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CONTENTS.

EDITORIAL: PAGE.
Paragraphs ... 291

ILLUSTRATED ARTICLES:
The Wenstrom Electric Railway System ... 293
The Westinghouse-Pullman Electric Car ... 294
An Aluminum Reduction Plant ... 294
The Electromagnet, by Prof. S. P. Thompson ... 301
Electrical Distribution by Transformers from Central and Eccentric Stations ... 303
Foote's Intermediate Speed Regulator ... 305
The Electrix Single Pole Switch ... 305

THE STREET RAILWAY CONVENTION REPORT:
President's Address ... 295
Electric Motive Power Technically Considered ... 295
The Edco Storage Battery Street Car, by D. H. Bates ... 295
Remarks of A. H. Chadbourne ... 297
Remarks of Malone Wheless ... 297
Remarks of Knight Neftel ... 297
Remarks of A. H. Potter ... 297
Remarks of W. J. Carruthers-Wain ... 297
Remarks of E. E. Higgins ... 298
Remarks of E. H. Johnson ... 298
Remarks of Geo. W. Mansfield ... 296, 298
Convention Notes ... 298
The Attendance ... 299

MISCELLANEOUS:
Moonlight Tables for November ... 292
The Education of Electrical Engineers. By Prof. Arthur T. Woods ... 292
Convention of the American Street Railway Association ... 292
The St. Louis Exposition ... 300
Water Power and Electric Transmission ... 300
The Electrodynamics of Stationary Bodies. By H. Hertz ... 302
The Central Lighting Station as an Investment. By B. E. Sunny ... 304

SPECIAL CORRESPONDENCE: New York Notes, 306; New England Notes, 306; Philadelphia Notes, 306; Western Notes, 306; Southern Notes, 307; English Notes, 307.

NEWS OF THE WEEK: The Telegraph, 308; The Telephone, 308; The Electric Light, 308; Applications of Power, 308; Miscellaneous Notes, 308; Personals, 308.

INDUSTRIAL AND TRADE NOTES ... 308
ANSWERS TO CORRESPONDENTS ... 309
BUSINESS NOTICES ... 309
OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS ... 309

Endorsement of the Storage Battery. ONE of the most striking facts noticeable at the Street Railway Convention was the interest displayed by practical railway managers in the storage system. There seemed to be a general feeling, especially among those whose lines were in cities of the larger size, that something aside from the overhead system was most emphatically desirable; and it was freely stated that the storage battery was a factor in electric traction which should not be lightly passed by. Much notice was taken of the Edco car which was exhibited, and, so far as the general consensus of opinion of street railway men can go, it may safely be said that the time is ripe for the development of a successful storage system. Whether those now before the public can meet the somewhat severe conditions imposed upon them, experience only can tell; but it is very certain that the advent and great success of the overhead systems has not at all occupied the field to the exclusion of any thoroughly practicable storage battery or underground supply electric railway.

An Investor's View of Electric Traction. A PAPER on electricity as a motive power, read by Dr. Allen at the Street Railway Convention, is a very useful contribution to our knowledge of the working details of electrical traction. Dr. Allen was one of the pioneers in the practical operation of electric railways, and his experience has been a wide one. It further possesses the advantage of being from the standpoint of the investor instead of from that of the electrician. He shows quite plainly that there is considerable still left to be desired in street railway apparatus, although he bears witness to the many good qualities possessed by what we now have. If more street railway managers would speak out plainly regarding the results of their actual experience with commercial apparatus, the public would be in much better position to judge of the real merits and defects of electric traction as at present practiced. Of its merits in greatly increasing traffic, there can now be no doubt. Its weakest points however are not generally known, except to those who have suffered from them. It is to be hoped that Dr. Allen's example in giving some cold-blooded facts as to details of operation will be followed by others.

The Street Railway Convention. THE meeting of the American Street Railway Association at Buffalo, of which a full account is given elsewhere in our pages, may be considered an unqualified success. It was largely attended by street railway men, and the electrical industries were represented with a completeness that is seldom seen at any similar gathering. The exhibits were especially fine, and the way in which they were received could leave no doubt in the mind of the observer that electricity is the coming means for operating street railways. To be sure, the horse was not finally buried with appropriate honors during this convention, but the president of the association deliberately expressed his belief that the present was the last convention at which the horse would ever receive serious discussion. It would be hard to find a body more thoroughly enterprising than the American Street Railway Association, and a more thoroughly wide-awake throng of delegates could scarcely be imagined. The practical railway manager of to-day keeps himself pretty well posted as to things electrical, especially if he has had some chance for experience, and is quick to see the advantages of new apparatus and methods. There is good reason to believe that subsequent conventions will exceed even the present one in enthusiasm and enterprise, and it is to be hoped that the representatives of the electrical houses occupied in street railway work will be encouraged to turn out in increasing numbers at the Pittsburgh meeting.

The Wenstrom Railway System. WE give in the present issue some account of the new Wenstrom electric railway system, which will prove of interest to many of our readers. The special points of this group of devices for electric traction are the slow speed of the motor, and the introduction between the motor and axles of a variable hydraulic driving gear, which allows the load to be put on gradually, or permits of the motor running all the time if desirable. The former advantage is secured by the use of a four-pole motor, with the more than usually powerful field possible with the Wenstrom construction. The latter is effected by what is practically a rotary pump forcing a liquid through a closed circuit containing a valve, running freely when the valve is open, and transmitting the full force of the motor through the intervening liquid piston when the valve is shut. It is somewhat questionable whether it would be desirable to keep the motor rotating all the time, even with this gear, for the result would be to increase the wear considerably, and to keep up slight losses without any corresponding advantage. The ability to apply the load gradually, however, is very useful, and the freedom from intermediate gearing secured by low speed is a very positive advantage. The hydraulic gear has behaved admirably in experimental use, and if it can be kept tight in the severe strains encountered in actual service, should prove a very useful addition to electric street railway apparatus. It should be noticed that the arrangement allows graduation of speed by permitting a variable slip in the hydraulic gear, although the economy of this method of speed regulation, compared with the use of the rheostat and commutation of field coils, needs to be the subject of thorough experiment. The novelties in the system are sufficient to secure for it very close attention on the part of street railway men, and enough has been said to show that they are of a decidedly useful character.

Magneto-Optical Generation of Electricity. SEVERAL of the electrical papers, both in this country and Europe, have taken notice of some experiments recently published in the *American Journal of Science*, of September last, bearing on the magneto-optical generation of electricity. Of course it is well known that certain substances when placed in the magnetic field produce powerful rotation of a beam of plane polarized light passed through them in the direction of the lines of force of the magnetic field. The attempt recently made by Dr. Sheldon to reverse this effect and obtain from a rotated beam of polarized light an electric current, resulted in apparent success. It should be pointed out, however, that there is, theoretically, no reason for obtaining any result due to the supposed cause by the method of experiment employed. The rotation of a Nicol prism, or its equivalent, is not all analogous to the rotation impressed on the beam of light by an electromagnetic field. It should be borne in mind that the magnetic forces in that form of electromagneto-radiation, which we denominate "light," are not in the direction of propagation of the ray, but perpendicular, both to it and to the electrical forces in the wave front. There is no reason, therefore, why we should expect a reversal of the well known effect on the light observed by Faraday; nor, by the rotation of a nicol, will there be produced the same sort of twisted wave motion that results from the presence of certain substances in an electromagnetic field. There being no theoretical reason for the existence of the effect observed by reason of the rotation of the plane of polorization of light, we must probably look to other causes for the current obtained. The experiment has been tried heretofore with negative results. It is possible that some thermo-electric disturbance may have produced the undoubtedly interesting phenomena observed; but the exact cause can, of course, only be determined by thorough investigation.

Electricity in the Technical School. THE perplexing questions suggested by Prof. Woods in his paper on another page are exceedingly pertinent to the educational situation. Of a sudden, within less than a decade, a new profession comes into being and assumes an important place in the complex civilization in which we live. There are no precedents to show by what training, through what judicious union of theory and practice, the student may best be fitted for its varied demands. The pioneers in electrical engineering were the product of no special line of experience that can reasonably serve as a guide for the teaching of to-day. They gathered around the new art from the workshop of the skilled artisan, the telegrapher's key and the professor's chair. But to-day it is as ill advised to enter the higher branches of electrical work without careful and special training as it would be for a carpenter to start suddenly in business as an architect. As schools for electrical training have been evolved from the existing needs more than one line of development has been followed. Perhaps one of the commonest methods has been that suggested by Prof. Woods, the modification of existing courses in mechanical engineering. Such at least has been the line followed in many of the technical schools. The now famous *dictum* of Sir William Thomson that an electrical engineer should be nine-tenths mechanical engineer has been regarded as sufficient justification for such a process. For one blessed with a portion of the almost intuitive perception of complex electrical theory that characterizes that greatest of living physicists, the statement might be unequivocally true, but the average student needs the closest kind of drill at electricity pure and simple before he is competent to grasp the meaning of the occult phenomena with which the electrical engineer of to-morrow will have to deal. No amount of practice at the lathe and forge will help him to comprehend modern electromagnetic theory. In so far as the manual training goes, a course of mechanical engineering is no better from an electrical point of view than an apprenticeship in a machine shop. The work which tells is the general grasp of several allied branches of physical science and a familiarity with common sense applied mathematics. Somewhat of handiness at metal working and work-shop processes is valuable to the electrician, but it is experience gained at a high price if at the expense of technical study. Manual training is no substitute for intellectual training, although it sometimes may supplement it most effectively. Unless the combination is made very judiciously, however, the student will spend a great deal of time in becoming an indifferent mechanic. Many technical schools of to-day are somewhat in the position of the unfortunate hero of "The Buntling Ball,"

> "For Alonzo seeks to walk
> Two diverging ways at once."

It is possible in the too brief space of four years that is allotted to the higher education of most young men to give in the manual training school a capital elementary mechanical education, coupled with considerable expertness at various sorts of handicraft, or, on the other hand, in the technical school to give a pretty thorough education in modern applied science. The two courses, however, cannot be combined in the same space of time without one or the other giving way. This union has been the subject of experiment with various degrees of skill, and the answer to Prof. Woods' question depends on the way in which this has been accomplished. In a school that is consistently practical or deliberately theoretical, the problem is comparatively easy; but where the two are already partially superimposed it is hard to find space for added electrical studies without crowding out something that appears necessary. It seems probable, on the whole, that the mechanical and electrical courses should begin to diverge as soon as practicable, without separating widely, unless near their end. We should be much pleased if both electrical engineers and educators would follow out Prof. Woods' suggestion, and give this very interesting question the benefit of free discussion.

Moonlight Tables for November.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of November, under his modified form of moon schedule.

Schedule for November, 1890.

TABLE NO. 1. Standard Moonlight Philadelphia System.

Date.	Light.	Date.	Extinguish
1	5:30 P.M.	1	9:30 P.M.
2	5:25	2	10:25
3	5:25	3	11:20
4	5:25	5	12:20 A.M.
5	5:25	6	1:20
6	5:25	7	2:20
7	5:25	8	3:20
8	5:25	9	4:20
9	5:15	10	5:40
10	5:15	11	5:40
11	5:15	12	5:40
12	5:15	13	5:40
13	5:15	14	5:40
14	5:15	15	5:40
15	5:15	16	5:50
16	5:15	17	5:50
17	8:30	18	5:50
18	9:40	19	5:50
19	10:55	20	5:50
20			
21	12:05 A.M.	21	5:50
22	1:20	22	5:50
23	2:30	23	5:55
24	3:40	24	5:55
25	No light.	25	No light.
26	No light.	26	No light.
27	No light.	27	No light.
28	5:05 P.M.	28	7:20 P.M.
29	5:05	29	8:10
30	5:05	30	9:10

Total hours lighting, 208 55.

TABLE NO. 2. Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	5:30 P.M.	1	12:00 M.
2	5:25	2	12:0
3	5:25	3	12:00
4	5:25	5	12:20 A.M.
5	5:25	6	1:20
6	5:25	7	2:20
7	5:25	8	3:20
8	5:25	9	4:20
9	5:15	10	5:40
10	5:15	11	5:40
11	5:15	12	5:40
12	5:15	13	5:40
13	5:15	14	5:40
14	5:15	15	5:40
15	5:15	16	5:50
16	5:15	17	5:50
17	5:15	18	5:50
18	5:15	19	5:50
19	5:15	20	5:50
20	5:15	21	5:50
21	5:15	21	12:00 M.
22	1:20 A.M.	22	5:50 A.M.
22	5:15 P.M.	22	12:00 M.
23	5:05	23	12:00
24	5:05	24	12:00
25	5:05	25	12:00
26	5:05	26	12:00
27	5:05	27	12:00
28	5:05	28	12:00
29	5:05	29	12:00
30	5:05	30	12:00

Total hours lighting, 287.35.

The Education of Electrical Engineers.

BY PROF. ARTHUR T. WOODS, UNIVERSITY OF ILLINOIS.

An examination of the courses of study in electrical engineering at several of our leading technical schools, as described in their catalogues, shows that the college faculties which devised these courses held widely different views as to the best collegiate training for future electrical engineers. It will probably not be questioned that the work of the practicing electrical engineer involves a detailed knowledge of the theory and practice of several branches of mechanical engineering, notably steam and water power, mill work and the design of high speed machinery. Collegiate work in electrical engineering is, therefore, generally based on the course of study previously established in mechanical engineering, and as it is not practicable to arrange the former course by simply adding to the latter, on account of the limited time available, some substitutions must be made. The question then arises, What studies are to give way to purely electrical work? It is here that we find a great difference of opinion.

In one well-known college the courses diverge after the first year, the time devoted to shop work, mechanical laboratory, designing and applied mechanics in the mechanical engineering course being reduced and some subjects, such as metallurgy and heating and ventilation, being dropped out. The time thus gained is devoted to electrical work, together with a considerable proportion of advanced pure mathematics. The most marked reductions are in shop work and designing. In another college the two courses are identical during three years, the mechanical shop work, designing and mechanical laboratory work of the fourth year being replaced by distinctly electrical work. In still another college the courses diverge after about two years, and some chemistry, metallurgy, astronomy, geology, etc., give way to some additional mathematics and to text-book and laboratory work in electricity. The shop work is nearly the same in both courses. Then there are other institutions which, while they have no separate electrical engineering courses, include considerable electrical work in the mechanical engineering course, possibly on the basis that while "an electrical engineer must be nine-tenths a mechanical engineer," it is also necessary that the latter should have a thorough knowledge of electrical principles and be familiar with their practical applications, whatever the special branch of mechanical engineering in which he engages.

It is, of course, understood that by graduating with the degree of M. E. or E. E. a student is not thereby made a mechanical or electrical engineer, but he has satisfactorily passed through a preliminary training which fits him for completing his education by the addition of practical experience. The student should therefore be thoroughly drilled in the theoretical or book knowledge which can be best learned under instructors, and he should also receive some training in practical work, so that his services will have some commercial value, or that he will have something to sell when he leaves school.

Now the question on which the writer would like to see opinions in the columns of The Electrical World from those of its readers who are practicing electrical engineers is, What is the proper scope of an electrical engineering course of study in a technical school? Or, in other words, assuming that a college has a well-developed mechanical engineering course, including the usual range of mathematics, physics, chemistry, mechanics, mechanical drawing, designing, prime movers, millwork, mechanical laboratory work and shop practice, with no electricity excepting that included in a year's work of say two hours a day in physics, what studies should be eliminated in laying out a course of study in electrical engineering, and what should be substituted? How much time should be given to electrical measurements, or purely laboratory work, and how much to dynamo and motor design and the economic problems of electrical transmission of power? Is it desirable to do away with shop practice or to make a great reduction in the time so employed?

It is assumed that the proposed course is intended for the training of electrical *engineers*, and not for that of *electricians* simply, and, that in view of the mechanical knowledge required of the former, the time available in a four years' college course will not permit of the extended practice in the physical laboratory which could be given the latter.

Convention of the American Street Railway Association.

The ninth convention of the association was held in Buffalo, Oct. 15, 16 and 17; and it may be put down in the records as a most decided success. There was a very full attendance of delegates, and the electrical industries were represented with a completeness seldom found at gatherings of this sort.

The headquarters of the association was at the Hotel Iroquois, but the accommodations there proved insufficient for the crowds who came, and all the neighboring hotels had their capacity severely tested by the throng.

The convention formally opened in the hall of the Buffalo library building at 10 o'clock Wednesday morning, President Thomas Lowrey in the chair. After roll call, the president arose and delivered the opening address, which was listened to with the greatest interest. He spoke briefly, but covered many points of the most immediate importance to street railway corporations.

The regular business of the meeting was then taken up, and after the report of the standing committees the first of the special reports was heard from Charles Odell, superintendent of the Naumkeag Street Railway Association, of Salem, Mass.

In spite of the prediction made to the president that the present was the last convention at which the horse would be seriously discussed, this paper proved to be not at all a requiem over the departing animal, but was a description of what was most desirable in horses for street railway service.

The second report, on the "Progress of Cable Motive Power," was held over until the next meeting, at the request of the author.

And then was read the principal electrical paper of the convention, by Dr. W. L. Allen, president of the Davenport, Iowa, Central Railway Company. It was a most interesting and careful résumé of the results of an extensive experience in operating electric roads, and was listened to with the greatest interest by the delegates present, as it is seldom that a more practical paper has been read before any similar body. It is reprinted in full on another page, as it is an important contribution to the progress of electric railroading.

This closed the first session of the convention, and in the afternoon a large proportion set out for the Cold Spring power house, where there was an important exhibit of electrical apparatus.

The Buffalo Street Railway Company did everything in its power to make the sojourn of the delegates pleasant, furnishing them a very pretty souvenir programme of the association and book of complimentary tickets to the Buffalo railway lines.

The convention then adjourned at 3 o'clock, in full force, to the Cold Spring lines, and the centre of attraction was the Westinghouse-Pullman electric car. This was a double truck, vestibuled car, finished in the most elegant manner. It was painted cream color and white, with gilt trimmings, while the upholstering was in embossed leather; and the vestibules were provided with curved plate glass fronts. It is a really beautiful specimen of the product of the Pullman shops, and its especial attraction to railway men was the fact that it was driven by two 15 h. p. Westinghouse railway motors. These were easily visible through convenient traps in the floor of the car, and their operation was inspected with the greatest care. The car was run all the afternoon, carrying crowds of enthusiastic spectators. It ran, in spite of its great length and weight, smoothly and quietly, and was under excellent control by means of the small vacuum brakes operated by one of the motors. As this is the first time the Westinghouse motor has been open to public inspection, the occasion was a notable one, and the greatest pains was taken to explain the excellent mechanical properties of the new machine. Besides this, the Thomson-Houston Company exhibited two large track machines, a snow plow and a sweeper, which were operated, so far as they could be, on clear tracks, at intervals through the afternoon.

Still another car was presented in the Electrical Accumulator Company's exhibit of the Edco car, which was inspected by crowds of visitors, and made frequent trips over the road, running to the satisfaction of everybody.

After an afternoon spent in the inspection of these practical displays, the delegates returned to the headquarters, and in the evening an executive session, attended by active members only, was held, at which there were some important discussions.

Thursday morning opened with the remaining papers and committee work, and some executive business was also transacted. Some special electrical discussion appeared, although most was reserved for the afternoon.

About 3 o'clock the third session opened, and after the election of officers, Henry M. Watson, of Buffalo, being chosen president, the technical side of electric traction was taken up by various experts in behalf of their several systems. Mr. Higgins spoke for the Edison Company, and presented its claims in a telling fashion. He was followed by Edward A. Johnson, of the Interior Conduit and Insulation Co., who discussed the necessity, particularly in cities, of underground feed wires, and described the simple and successful method used by his company in maintaining a cheap and effective underground insulation. During the day Mr. Mansfield, of the Thomson-Houston Company, and Mr. Potter, of the Brush and Short Electric Companies, had effective words to say for the good points of their several systems, as did Mr. Neftel for the United Electric Traction Company, of New York; Mr. Wheless, of the Wheless Electric Railway Company; and Mr. Bates, of the Electrical Accumulator Company.

The practical street railway men seemed to display an unusual amount of interest in the details of the storage system at this convention; especially those whose lines, operated in city streets, felt the need of some system of supply which should not involve the use of overhead wires. In this connection the Hon. W. J. Carruthers-Wain, president of the Tramways Institute of Great Britain and Ireland, was invited to give his experience in the operation of storage batteries. His address was exceedingly interesting because of his very wide experience, as he is at present connected with seven different tramway companies in the United Kingdom, and has under his control, horses, steam, cable, and electric lines, he was especially competent to speak on comparison in these various motive powers. He was enthusiastic in his belief in the storage battery as the tractive power of the future.

A vote of thanks was passed, thanking him for his valuable addition to the general interest of the convention, and a cordial invitation accorded him to be present at coming conventions.

A resolution of thanks to the traffic associations for their courtesy in furnishing special rates of transportation, was then passed; and President Lowry retired from the chair, introducing the newly elected president, Mr. Watson, who delivered a brief address, and the formal business of the association then came to a close, the remainder of the time being reserved for less business-like, and more agreeable social enjoyment.

In the evening occurred the annual banquet of the association, which proved to be a brilliant success, both as to its gastronomic and intellectual features. An admirable orchestra was in attendance, and played well-chosen selections at intervals through the evening.

After the necessary and informal process of eating the dinner had concluded, Mr. Charles F. Bishop, of Buffalo, delivered a cordial address of welcome to the street car men. He was followed by Mr. E. C. Sprague, Mr. C. B. Holmes, Hon. W. J. Carruthers-Wain, Mr. Henry W. Box, Mr. C. A. Richards, Mr. J. H. McGraw, Mr. John Laughlin and Mr. Edward Fleming, after which the informal exercises were kept up until a late hour.

Friday morning the delegates fell into the hospitable hands of the local committee, and at eleven o'clock in the morning nearly 400 guests left on a special train for Niagara Falls, which was reached after a run of a little less than an hour. Crossing to the Canadian side, the visitors crossed the upper suspension bridge (carriages being provided for the ladies) and spent an interesting hour wandering about the Falls, wherever their fancy dictated. Some of the more adventurous ones ventured into the "Cave of the Winds," but for the most part, much was found to see without resorting to such aqueous measures, and at 12 o'clock the entire company repaired to the Cataract House, where an elegant lunch was spread. This was discussed even more vigorously than the papers of the day before. At three o'clock a special train, furnished by the courtesy of the railway company, was ready for a flying trip down the beautiful Niagara gorge, wonderfully lovely in its gorgeousness of autumnal foliage, to Lewiston. The observation cars afforded ample opportunity for viewing the scenery, and the delegates found the time all too short ere the return to Buffalo would be necessary. A little after four o'clock the observation train returned to the Falls; the special train of the morning was ready, and the convention returned to Buffalo after an enjoyable excursion.

Too much cannot be said of the courtesy and attention shown to the delegates on every hand, and every one left with the feeling that in hospitality—as in some other things—Buffalo was very hard to beat.

So closed what may be regarded as perhaps the most successful meeting of the American Street Railway Association yet held. To the electrical railway manager it was doubly interesting on account of the elegant and numerous electrical apparatus and equipment material which were visible on every hand.

The next meeting will be held at Pittsburgh, where the success of the present one ought to insure an attendance even larger and more enthusiastic. Each successive convention has added interest, from the electrical standpoint, and we may readily believe that next year's meeting at Pittsburgh will not be behind the present one in this respect.

The Wenstrom Electric Railway System.

One of the most interesting displays at the convention of the American Street Railway Association, just concluded, was the exhibition by Messrs. Chadbourne, Hazelton & Co. of apparatus for electric street railways, including the Wenstrom generator and motor and some interesting and valuable inventions of their own in driving gear.

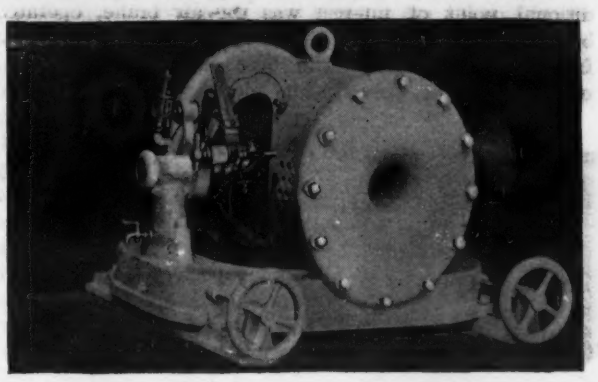


Fig. 1.—Wenstrom Railway Generator.

The complete system is in some respects a very radical departure from present street railway practice, and, as such, is worth more than a passing notice. It is the purpose of this article to give a connected description of the features of this new electric railway system. It has not yet been put into operation on a road of its own, although the preliminary experiments have met with very gratifying success. The first Wenstrom road, however, will probably be started within a very short time, and its merits will be shown more widely to the public than is possible from any description that can be given.

To begin at the beginning, it is worth while saying something of the Wenstrom generator. Although the machine is by no means new, yet there have been recent and important improvements. The Wenstrom machine has for its fundamental point in design a short magnetic circuit as nearly closed as the mechanical exigencies of the case will allow. The type of field magnet is that which has come to be known as the "iron clad," where the magnetic circuit completely shuts in the armature and field coils so that as one looks at the machine from the outside nothing is visible except smooth, easily curved, surfaces of iron. The merits of the type are two: First, absence of external magnetism, and, second, economical and convenient arrangement of the magnetizing coils.

The present machines have four poles, two of them salient poles, magnetized directly, and the other two consequent poles, formed by a cylindrical surface cut into the iron of the field magnet. In general design the machine consists of a cylindrical-shaped body of cast iron capped with end caps of the same material, with a lateral aperture through which the armature is thrust. Fig. 1, from a photograph of a large machine, gives an excellent idea of the general appearance of the Wenstrom dynamo, while Fig. 3 shows a section lengthwise through it, exhibiting the manner in which the field coils are slipped upon the salient poles and the arrangement of the magnetic circuit which gives a four-pole machine of such compact and convenient shape. The simplicity and strength of the construction speak for themselves. But perhaps the most extraordinary feature of the Wenstrom machine is the armature, which does not present the familiar appearance of a core wound with wire, but rather seems to be a smooth cylindrical mass of iron turned and polished on the exterior and barely out of contact with the pole-pieces. The winding consists of wires passed through apertures cut lengthwise through the core just under the surface. These are actually stamped in the iron discs of which the core is built up. We may then imagine the Wenstrom armature as a modified drum armature furnished with Pacinotti projections closed over the top, however, by a thin casing of iron. As a matter of fact the apertures which receive the windings come within so short a distance of the external surface of the armature that only a very small amount of magnetism is lost by leaking around the armature on the outside of the wires, while the complete freedom from external winding allows this type of armature to be run with a gap in the magnetic circuit enormously less than can be found in any other construction. As a natural consequence the magnetism is cheaply obtained, and the armature wires are subjected to a very powerful induction. The external magnetism of the machine is almost nil, and the interior leakage is apparently not severe. The armature is well shown in Fig. 2. The result of this construction is, as might be expected, to secure admirable efficiency with intelligent electrical design.

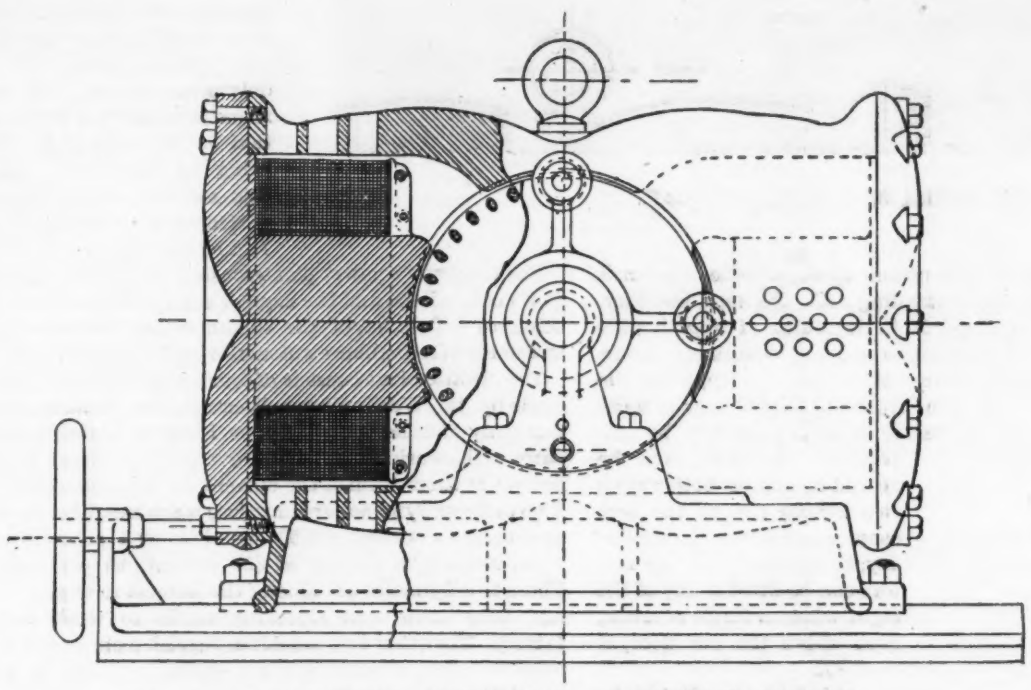


FIG. 3.—LONGITUDINAL SECTION OF WENSTROM DYNAMO.

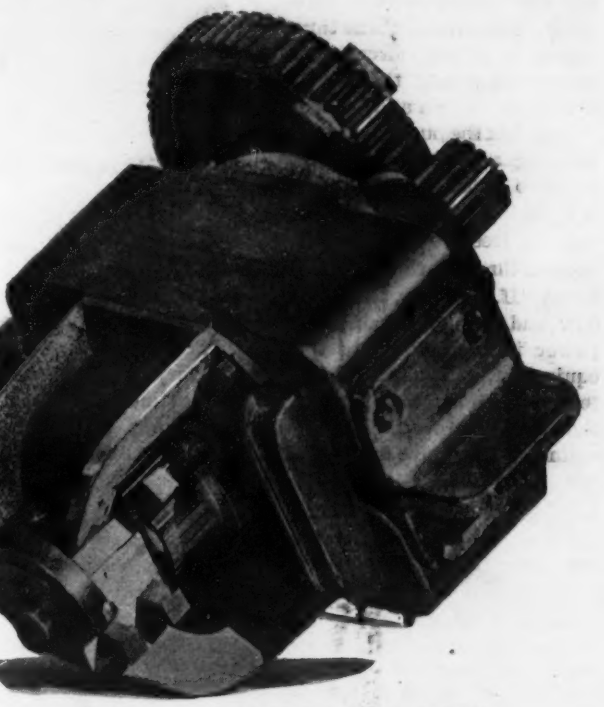


FIG. 4.—WENSTROM STREET CAR MOTOR.

The street car motor shown in Fig. 4 has all the characteristic features of the generator, although, as will be seen, the frame no longer attains the cylindrical form, but is flattened into a somewhat more compact shape. It is, like the generator, a four-pole machine, the magnetic circuit being cast of mitis metal in one piece, with, as before, two consequent and two salient poles. The frames which sustain the armature are bolted to the sides of the field magnets and are readily removable, permitting, therefore, the removal of the armature and consequently of the field coils, which, when the armature is taken out, can be slipped off the pole-pieces with great readiness. The armature is of the same type as the generator and runs within one-sixteenth of an inch of the pole-pieces. The commutator is provided with two brushes only, 90 degrees apart, the armature being cross-connected so that this arrangement is possible. For convenience in taking off the armature the pinion seat is tapered so that the armature pinion can be very readily slipped off. On moving the supporting frame the armature can then be slipped out with the greatest readiness.

The standard street car motor is rated at 25 h. p. and weighs, complete, very nearly one ton. Owing to the powerful magnetic field practicable with the Wenstrom construction, and to the fact of the new motor being a four-pole machine, its speed is only 400 revolutions per minute. The armature can consequently be geared directly to the car axle without the intermediate countershaft that has been the subject of frequent objurgations from every electric railway man who has been in the business long enough to have gearing give out. A small convenience which should be mentioned here is that the brush holder is fitted to the outside of the bracket which supports the armature on the commutator end, so that it can be adjusted or taken off without loosening the armature frame at all. Messrs. Chadbourne & Hazelton prefer, for various reasons, to fit street cars with one motor instead of two, and the present machine has been designed with this in view. The reasons for the choice will be known to those who have followed closely the progress of experiments in electric traction, but may be briefly restated here. It is no easy thing to get two motors to pull together on the same car; in other words, to wind them so that they shall run at exactly the same speed with the same current. Consequently in many cases the power is not divided equally between the two machines, and one of them is overloaded while the other is running light, often producing serious results, as has been shown beyond controversion, by recent experiments of Hale (The Electrical World, Vol. XV., p. 330) and Crosby (The Electrical World, Vol. XV., p. 361).

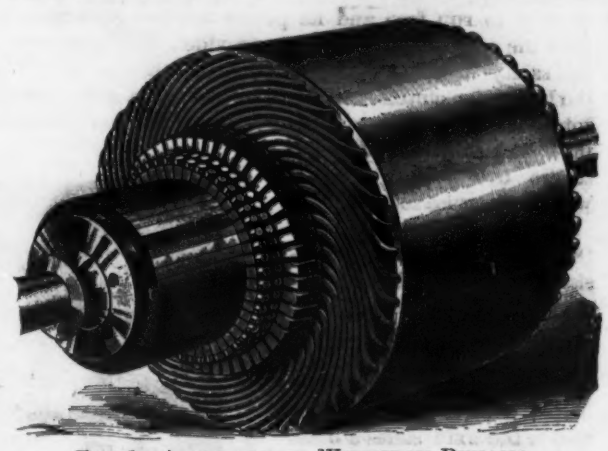


Fig. 2.—Armature of Wenstrom Dynamo.

The use of two motors probably arose originally from a lurking distrust in the reliability of the machines and the difficulty of gearing a single motor to both axles where it is desirable to drive both axles directly, as sometimes is the case on heavy grades. It is quite probable that with one motor properly geared to both axles any grade which it is desirable to surmount can be successfully taken. The absence of intermediate gear in the Wenstrom motor is of very considerable advantage, as it has already been shown (loc. cit.) that losses in gearing may rise to a serious amount in the motors now in use. The standard construction adopted for the Wenstrom street car system is a single 25 h. p. motor geared to one axle, the split gear being preferably of the wooden tooth construction recently

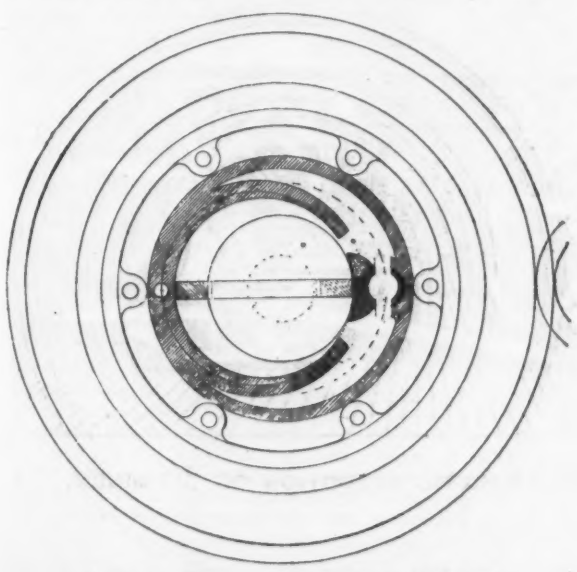


Fig. 5.—Section of Hydraulic Gear.

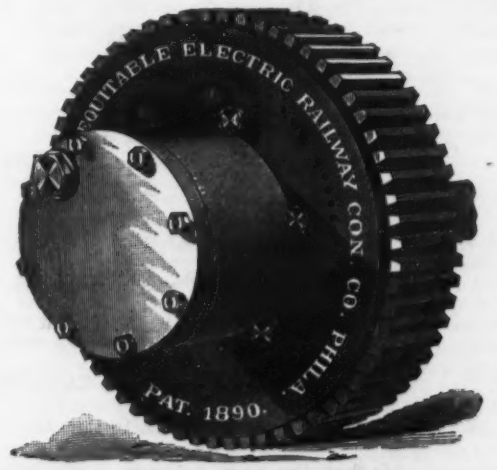


Fig. 6.—Hydraulic Gear.

introduced by Chadbourne & Hazelton. Perhaps, however, the most ingenious modification of present street car practice is to be found in the hydraulic gear which forms the connection between the split gear and the driven axle. This has been but recently worked out, and its purpose is to furnish a variable clutch between the driving and the driven axle, so that in starting the motor it may be allowed to run free and its power applied gradually to start the car, and in addition to provide a sort of mechanical safety valve, so that when there is a severe overload the hydraulic clutch will slip and allow the armature to rotate fast enough to save it from the excess of current, instead of subjecting it to the severe overloading which would otherwise follow.

Fig. 5 shows a section of this hydraulic gear. It consists of a cylindrical cavity placed eccentrically to the driving shaft and turned up true and smooth within. It is fitted with a tight cover firmly bolted on. Through a disc fast to the axle slides a brass key, forming a partition across the eccentric box free to slide as the shaft turns, and forcing the oil with which the eccentric box is filled through a port in the rim connecting one side of the cavity with the other. The arrangement thus forms a rotary circulating pump of which this brass slide is the piston and the eccentric box the pump cylinder. So long as the port between the two sides of the piston is open the eccentric box can revolve freely, forcing the oil around through the port as it turns. If, however, the port is closed, the oil can no longer flow and forms an incompressible mass through which the power is transmitted to the axle. The arrangement is equivalent, as before remarked, to a rotary pump, the piston of which is free to move within the cylinder so long as the valves are open. When they are closed piston and cylinder must move together, if at all. The result of this arrangement is that, the port being open the split gear to which the apparatus is applied rolls freely around on the axle without communicating any motion to it. If, however, the valve is closed, the gear and axle act as a rigid body and the motor can exert its full force. Suppose the car to be at rest and the valve and hydraulic gear open, the motor on starting will revolve freely. Now gradually close the valve; as the passage for the oil is more and more contracted a greater and greater pressure will be exerted tending to turn the axle, and, although during this period there will be some slip, finally, however, as the valve closes the pressure is sufficient to start the car, and when the by-passage is completely closed gear and axle act as a rigid body, and there is no appreciable amount of slip. It will be seen that this hydraulic gear enables a flexible connection to be made between the axle and the gear, so that the latter will run freely or with varying amounts of resistance and slip up to the point where, when the valve is completely closed, the two are to all intents and purposes rigidly connected. It is worth while thus to go into details concerning this unique contrivance, for the reason that while it is simple its exact action might not be at first sight obvious. Fig. 6 shows the hydraulic gear as attached to the corresponding wheel. It is not a bulky contrivance, and is under perfect control from the platform of the car, from which point the valve can be regulated. It allows the armature to run, if desired, at a constant speed, whether the car is going at its full rate or standing still. Perhaps, however, its greatest convenience is in the matter of applying the power gradually at the start so as to avoid straining the armature or producing an unpleasant jar. In applying the Wenstrom motor and the hydraulic driving gear to a car equipment, any of the usual arrangements can be employed. One motor can be geared to one or both axles; two motors can, in the rare cases when it may be necessary, be employed, or the motors can be fitted to any of the eight wheeled forms of truck, even above the car floor, if desirble.

Fig. 7 shows an electric locomotive for drawing trailers in which this principle of placing the motor above the car floor is carried out. Altogether, the system is a most interesting one, and it will be seen at once that it possesses a large number of points of difference from the constructions generally employed. Some of these are, unquestionably, advantages, and the system appears to be most promising in its application to the electric street railroad of today. The first road is about to be started, and we shall, therefore, probably soon be able to discover the weak points of the apparatus, if any should be developed. At present speaking, it has only been tried experimentally, although rather carefully, and, so far as can be judged from those results, it possesses rare qualities. The electrical public will await with interest the crucial test of operating a regular road.

WESTINGHOUSE-PULLMAN ELECTRIC CAR.

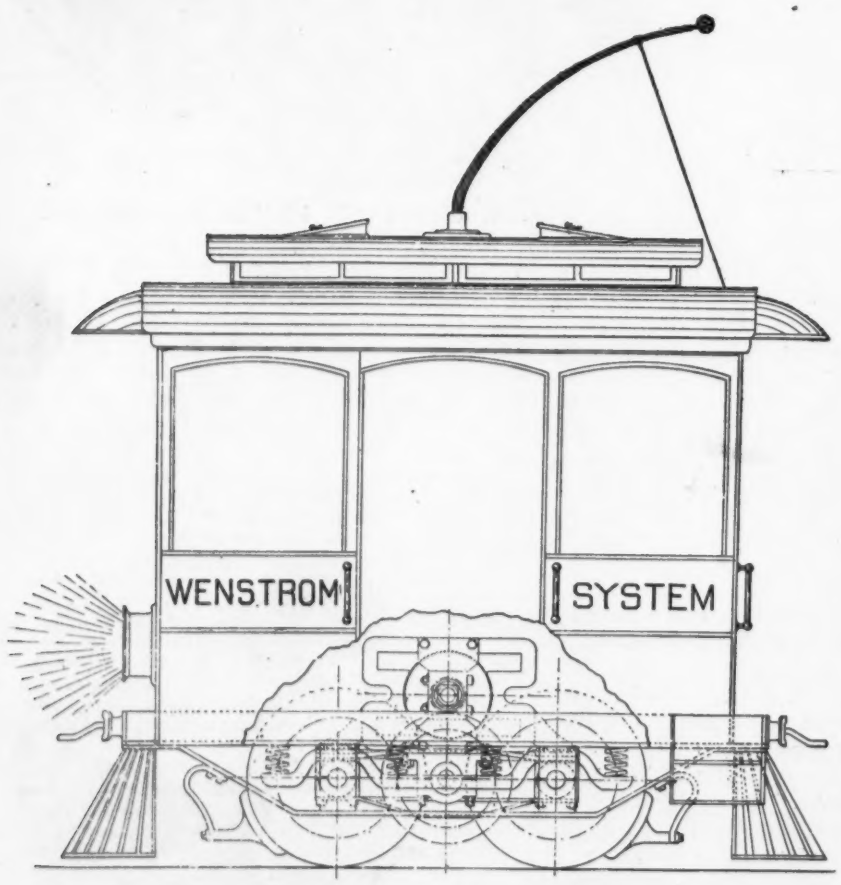


FIG. 7.—WENSTROM ELECTRIC LOCOMOTIVE.

The Westinghouse-Pullman Electric Car.

Our cut shows the beautiful motor car, equipped with Westinghouse apparatus, that attracted so much attention at the street railway convention. It consisted of a long, vestibuled car body 34 feet in length, built in the very best style of the Pullman shops. Each of the four-wheel trucks was fitted with a 15 h. p. Westinghouse motor, and an additional point of interest was the air brake, operated by a special pump driven by sprocket wheels from the car axle. The new car was in constant operation on the Cold Spring electric line and carried crowds of visitors on short trips up and down the road. It ran smoothly and with very little noise and the power brakes enabled it, in spite of its unusual weight, to be kept under perfect control. The interior fittings were of the most tasteful and elegant description and the whole reflected much credit on the two great companies that helped produce it.

An Aluminum Reduction Plant.

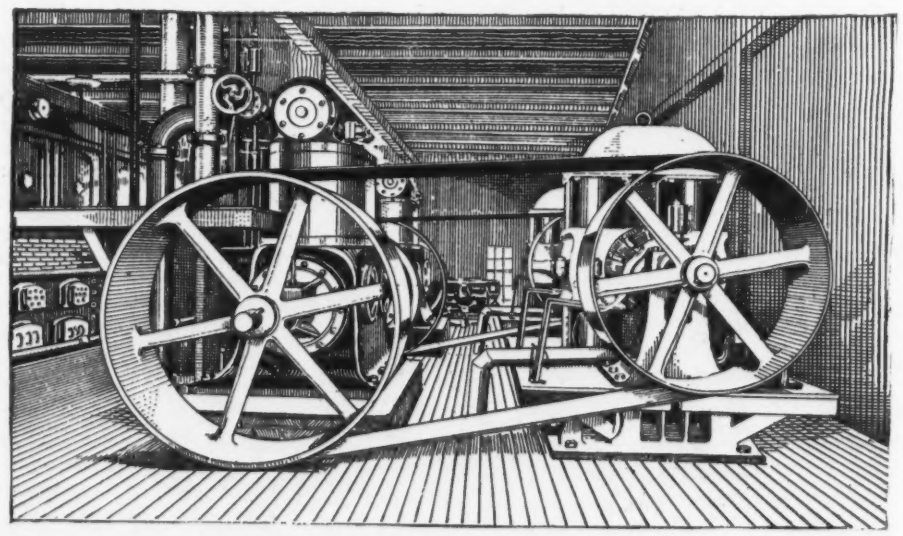
Aluminum exists in nature in the form of an oxide so refractory in its character as to make reduction in any ordinary furnace impossible, the only means which have been found available for its reduction on a commercial scale being by electrolysis. It is this method which has been perfected by the Pittsburgh Reduction Company.

The company's power plant consists of several Babcock & Wilcox boilers, and the engines are three in number, two being of 200 h. p., of the Westinghouse compound type, and one a Westinghouse automatic engine of 125 h. p.

The electric plant consists of four direct current dynamos made by the Westinghouse Electric and Manufacturing Company and the United States Electric Lighting Company, of Newark, N. J. These dynamos are shunt wound, and all of them furnish the current for the reducing pots. Two of these dynamos are immense machines, being wound to generate a current of 2,500 ampères at a pressure of 50 volts, running at a speed of 325 revolutions per minute. These two dynamos are among the largest in the country, and they have been especially made to work in this factory. The other two machines furnish a current of 1,000 ampères each, at a pressure of 25 volts, running at 1,060 revolutions per minute.

The two larger dynamos are connected in parallel, as well as the two smaller ones, though on an independent and separate circuit. The arrangements for transmitting the 5,000 ampère current from the two large dynamos are striking and somewhat novel in the way of electric current conductors, two copper bars, each 6 inches by $\frac{1}{4}$ inch, having a total area of cross section of 6 square inches, being used. For the 2,000 ampère current from the small dynamos a similar shaped bar, 4 inches by $\frac{1}{4}$ inch, is used. Fortunately, it is necessary to carry the current but a very short distance on such expensive conductors as these.

Since the works of the Pittsburgh Reduction Company have been operated, their production of this valuable metal has been constantly on the increase, and the demand is now so great that the company is contemplating an enlargement of its plant.



PLANT FOR THE ELECTROLYTIC REDUCTION OF ALUMINUM.

Proceedings of the American Street Railway Convention at Buffalo, N. Y.

The Ninth Annual Meeting of the American Street Railway Association was held at the Hotel Iroquois, Buffalo, N. Y., Oct. 15–17, 1890.

The president of the association, Mr. Thomas Lowry, of Minneapolis, Minn., presided, and was assisted by the secretary, Mr. Wm. J. Richardson, of Brooklyn, N. Y.

There was a very large attendance of street railway supply dealers, inventors, newspaper men and others, nearly every firm of importance and all the technical papers having representatives present.

The president of the association delivered the following address:

Gentlemen of the Convention—I am pleased to meet you in this beautiful city of Buffalo, assembled in the ninth annual convention of the American Street Railway Association.

I congratulate you upon the progress made and past good work of the association. When organized in 1882, in the city of Boston, street railroading was in its infancy, but such rapid advancement has since been made in city passenger traffic that the United States Government has deemed it of sufficient importance to incorporate in its census statistics for 1890 a report on street railways in cities of over 50,000 inhabitants. In this report 56 cities are included, and out of a total of 3,150 miles of track in these cities,

2,351 miles are operated by horses,
260 miles by electricity,
255 miles by cable,
221 miles by steam,

and the balance, about 60 miles, being the elevated roads in New York and Brooklyn. This report would seem to indicate that in the larger cities the faithful old horse is still the favorite propelling power for street cars.

The first special subject on which we are to receive a report from a committee appointed at the last convention is "A Perfect Street Railway Horse." From this we must assume that the association has not yet discarded the idea that the horse is the most reliable power for street cars.

In the smaller cities electricity is generally being adopted, and I am informed that there are already in operation in cities and towns outside of those enumerated in the Census Report, about 1,600 miles of electric street railways. I am so thoroughly convinced that electricity is the coming power for street railways (except on heavy grades where the cable is best suited), and that it will prove so effective, as a means of rapid transit for cities, that I believe this is the last convention that will ever seriously consider horses for the operation of street railways.

Rapid transit in growing cities is becoming a necessity. While municipal corporations in the larger cities, for many reasons, are slow to grant new privileges to corporations, and in the case of electricity they are very closely scanned and criticised, it will soon become self-evident that a municipal body can grant no greater boon to its middle and laboring classes than to provide them with the means of rapid and cheap transportation to and from homes in the suburbs, where they can live under a clear sky and in a health-giving atmosphere. When the people of a city understand clearly the great benefits of rapid transit, by electricity or other improved motive power over horses, they will demand that their city authorities grant such rights as will enable street railway companies to operate by the most improved methods.

Heretofore street railway securities have not been looked upon by the financial world with favor. However, since they have been so successfully operated by electricity the financial men of the country are looking to its development and application to street railways as an additional reliable security for the investment of savings and trust funds. This should give encouragement to street railway companies to give their various cities the most improved and best possible service. They will not only please their patrons, but the investment will prove very profitable. If street railway companies do this, no better security can be offered for the savings of the widow and orphan than a good street railway bond in a thriving city.

In order to bring this about, municipal corporations should grant liberal franchises for street railway improvement. The bond of the street railway company should be as good as the bond of the city in which it is located. The growth of the city is, to a large extent, dependent on street railway extensions, and the prosperity of the street railway company means the prosperity of the city in which it is located. It is one of the largest factors in the development of any city, and as necessary as are its schools and its churches.

On the other hand the street railway company should be required to equip its road with the finest and most modern cars, construct the best and most substantial tracks so as to inconvenience the public as little as possible in making repairs, and, in short, supply the road in every department with the best and most modern appliances of all kinds.

In view of the agitation of the labor question, it may not be out of place for me to say a word on that subject. In so doing it will only be the expression of an individual opinion, not intended to bind the convention to the views expressed. When organizations are formed by laborers and others for the purpose of building up and dignifying its members as men and women, or to improve their moral, physical or financial condition, no one would foster or favor them more than he who now addresses you. Unfortunately, however, most of the present so-called labor organizations are the worst delusion and snare into which a laboring man was ever entrapped. The recent "strike" on the New York Central road developed a state of cruelty, depravity and wrong that should make it the absolute duty of every corporation, having public interests to subserve and charged with providing for the comfort, convenience, business necessities, and above all the life and property of its patrons, to refuse to employ or retain in its employ any one who does not renounce his connection with the "Knights of Labor" or any other labor organization, the rules of which permit employés of a corporation to be "ordered to strike." Men have a right to quit work with such notice as the contract with their employers requires, either singly or in a body, if the terms of their employment are not satisfactory; but they have not the right to interfere with those employed to supply their places. The first duty of a lawyer is to his client, of a doctor to his patient, a minister to his congregation, and a teacher to his pupil. The engineer, the conductor, the switchman, have even a greater responsibility, as the lives of the passengers are in their keeping, and in order to properly discharge it they must be loyal to their employers. They cannot be plotting and laying out rules for their employer and be faithful in the discharge of their duty. "The laborer is worthy of his hire," but when he seeks to change the relation between himself and his employer, by asserting himself as master, he ceases to be the laborer that is "worthy of his hire." He also unfits himself for any kind of advancement. A man, to be successful, and take advantage of promotion earned by efficiency, must be contented and perform his work cheerfully. A "labor agitator" cannot be contented or work in the interest of his employer. A few days ago United States Commissioner Rogers rendered a decision at Baltimore, in a case where four sailors were arrested for refusing to go aboard a schooner after they had signed articles to do so. The Knights of Labor interfered and undertook to defend the prisoners. I cannot express my views better on this question than to quote from the decision of Commissioner Rogers, who said:

"I perceive you are men of intelligence and no doubt know and appreciate the advantages of union. Every man has a perfect right to unite with his fellow man to better his condition in life. There is one great mistake made, however, and that is the constant conflict of labor and capital. Now, I can't see why such a state of affairs should exist, because labor is in itself capital, and capital merely represents labor. A capitalist you will find is a man of strictly sober habits. He has to keep a clear head, and the man who to-day earns a dollar and to-morrow morning wakes up with 75 cents in his pocket is the man who may become a capitalist. No doubt your union is a good thing--the land we live in is a union. But now let me impress upon your minds that, while you have a perfect right to form a union, you have no right to interfere with the manner in which another man conducts his business. When a union attempts to interfere with or molest a free-born American, or tries to prevent his earning a living simply because he does not join that union, it then becomes a conspiracy, and amenable under the law and punishable by the court. The great trouble with the unions is that they overstep their bounds and endeavor to force people to do as they direct, and that is an act in direct violation of the laws which grant an American citizen his liberty. In these days of enlightenment and freedom the press—the most powerful agent of the people—is ever ready to air the grievances of any one who is oppressed or molested. Nothing, from the great acts of a government to the death of a pauper, escapes the eagle eye of the press. Tyrants fear the press more than any other power which can be brought to bear against them, and the press of America as it is to-day, edited by men of the greatest ability and highest order of enlightenment, is the bulwark of the country. Now, in conclusion, let me say to you that the man who endeavors to persuade you to fight against capital, except in a legal manner, is no friend."

I thank you for your attention, and I hope your deliberations will be characterized by the good judgment and discretion you have always heretofore exhibited."

The Treasurer's Report was read, and showed the financial transactions during the year to be as follows:

Receipts	$7,165.91
Expenses	5,389.96
Balance on hand	$1,775.95

The following is an extract from the report of the Executive Committee:

"The subject, 'Electric Motive Power Technically Considered,' was selected for the purpose of having the cobwebs, which were for the most part confessedly in our mind's eye, brushed away from this occult science, in order that it might be as plainly comprehensible to the ordinary street railway man as to the expert who manipulates the wires.

"The necessity for this knowledge is becoming greater as the days go by, for the transition of roads from horse to electric power is of almost daily occurrence, so rapid is the progress made by electricity as a motive power. In this connection we take occasion to say that the information which it is hoped will be freely given at this meeting concerning the cost of operation by electricity will, doubtless, still more rapidly hasten the emancipation of the horse from his bondage."

The report of the Committee on Electric Motive Power Technically Considered was as follows:

To go over the entire subject of electricity for street railways and consider all the technical details would occupy too much of your time. The subject naturally divides itself into

(I.) The Central Station.
(II.) The Transmitting Line.
(III.) The Motors.

The National Electric Light Association has so fully and exhaustively considered the matter of power or central stations that, most fortunately for street railway men, this subject is one that troubles us but little; but there are some points in which our work differs materially from that of an electric lighting station.

The engine we require must be strong in all its parts, for there is no work where the demands on it vary so suddenly and so frequently from the entire absence of load to the extreme capacity of the engine as in street railway work. Some roads report that the cars average but 5 h. p. each; supposing that such a road has eight cars in operation with one 150 h. p. engine in the station, and, as is often the case, the cars either become bunched or happen to start at the same instant; here a sudden demand is made upon the engine for 150 or 200 h. p., while a moment later the meter may register but 40 h. p. You will, of course, be provided with safety plugs and current breakers, but you cannot allow safety strips to be blown out half a dozen times a day, possibly just at the moment you are ascending a heavy grade.

Electric light men state that a station with a number of small high-speed engines is more economical on account of being more flexible in its operation; but in their business the loads upon the station vary gradually, while we may be called upon at any moment for our maximum capacity. To arrange our station for this varying load, and at the same time avoid operating a tremendous engine on an average light load, is a problem that experience must solve for us. We are also more greatly troubled with lightning than we should be. There should first of all be established as perfect a ground connection as possible, either by means of a well or a deep hole; it is better to have two grounds, and thereby make sure of a moist contact for galvanized ground plates or rods; then with proper lightning arresters, so placed that they can be conveniently examined and kept in order, we will be fairly well protected; but with our great lengths of exposed trolley wires we are very certain to have frequent calls upon our lightning arresters, and those in use at the present time are not such as to warrant perfect confidence.

Are we not all personally firm believers in the overhead system of transmission? What can there be simpler, cheaper, more durable and more convenient? We have only poles, bare copper wire, galvanized iron span wires, insulators and, where needed, additional feed wires, of which these last can be placed underground if desired. It is a rare thing to have a trolley wire break except at the curves. Curves are certainly troublesome on account of the constant liability of trolleys to jump off at some sharp angle, and the trouble is more generally due to faulty trolley stands, wheels or springs than to the overhead wire. For insulators we have only those for the straight line and those for the curves; and I show you a sample of each, such as were used two and a half years ago on one of our lines. It is not to be wondered at that street railway men at that time considered electricity, for the rough usage required by street railway work, to be in an embryonic stage of development. There is little to be asked for in the way of improvement of what we now have for overhead material. There is practically no difference whether we use the Thomson-Houston system, Sprague-Edison, Westinghouse or what not; a single trolley wire which may be large and heavy, say 00, and thus avoid feed wires where distance for transmission is not too great, or the wire may be small, say number 4, light and easy to handle, with, in that case, the necessary feed wires. We can take our choice and find equally good results with either. It will often be convenient to utilize both plans, with the large trolley in the central parts of the city where feed wires might not be desirable, and with the small overhead and feed wires to re-enforce the suburban parts. Undoubtedly the small wire is more easily handled and repaired in case of a break, and the feed wire prevents a dead line being the result of a break. The rail bonds may be galvanized iron, which cost but four cents, instead of tinned copper, and the supplemental ground wires can be of the same material. The supplemental wires do not give any better return except so far as to prevent a bad break in the return circuit, which might occasionally be caused by the breaking of both rail bonds at neighboring joints. Rails on both sides of the track should be connected with bonds.

It will not be necessary to discuss the merits of the conduit system or the storage battery. Actual experience has proven that there need be so little trouble or danger from the station and overhead line that we cannot concede the need of either conduit or storage battery, so far as *we* are concerned. It is true that the ever-restless mind of the public has been so stirred up by accounts of the numerous successful storage battery and conduit railways, that it has suddenly (and to us most unpleasantly) become aware of the fact that we are using *poles*, and while we are congratulating ourselves upon the beauty and symmetry of our neat line of poles, it suddenly demands that we remove what it terms our unsightly poles. Nearly every one of the street railway men present will uphold the statement that the only problem before us, and the one about which we are always anxious is, "What can we do to keep our motors out of the repair shop?" We don't worry about our station or our overhead wires; we scarcely have time to think of them; we are constantly at work upon and perpetually annoyed by our motors; a lame armature, a burnt field magnet, a broken gear—these are our every-day trials. A motor, such as is made by the Thomson-Houston, Sprague-Edison, or Westinghouse companies has among its mechanical parts an axle gear and intermediate shaft gear, shaft pinion and armature pinion, and the axle and intermediate shaft and armature have each their boxes or bearings. We want gear and pinions to be wide and heavy enough not to break. We don't want any more pinions like this, which was in use two years ago. We want gear of some material that will be reasonably durable, and at the same time noiseless; cast iron may do for the axle gear, which is large and runs slower, and steel for the intermediate shaft pinion; steel, we believe, is better than bronze, as it lasts longer and is less expensive. To overcome the noise it is necessary either to have the gear covered and running in oil, or to have the gear of wood or the pinion of raw hide. The large gear on the axle and intermediate shaft, if made with wooden teeth and used with steel pinions, certainly runs noiselessly, and it ought to make the life of the pinions much longer. Care must be taken to have the keys in all gear and pinions tight and self-retaining. The shaft boxes and bearings must be made of some compound metal that will not wear out too fast, for but little wear on the armature bearing will allow the armature to scrape on the pole pieces of the motor, be damaged and laid up for repairs. Aluminum bronze gives satisfaction as material for the bearings.

The electrical parts of the motor in which we are most interested are the armature, field magnets and the controlling switch or rheostat. The armature of an electric motor is its most wonderful and interesting as well as its most expensive and troublesome part. A street car is the most overloaded vehicle known to mankind. It may run a week with a light load, and then suddenly receive enough passengers to load fairly well three or four ordinary cars; the driver may forget to oil either the car or motor, he may reverse the motor accidentally or purposely to avoid an accident; these and many other causes require of an armature more work than it is capable of, hence a burnout. On the other hand, the armature itself may be at fault. An armature such as we use to-day consists of a shaft surrounded by a metallic core. Around this core is wound the best insulated wire, each coil terminating at the same end of the armature and being attached there by means of solder or screws to the bars of the commutator. The shaft of the armature will in a few years become worn by its bearings, and it would be well to have bushings or sleeves placed around the shaft at those points, such as the Thomson-Houston Company use, which sleeves can be removed. As there is no wear to the core, and as the commutator can be renewed when worn down, which ought not to occur in less than two or three years, an armature should then have as long a life as one could desire, were it not for the coils of wire. Where these coils cross around the head of the armature they chafe on each other and destroy their insulation. Where they end in the commutator they loosen, by an excessive load or careless driver they burn out. It

may be possible to repair the armature by rewinding one coil or by refastening the loose ends, and even when a deep coil is burnt the total rewinding with new wire should not cost but forty or fifty dollars. Could we but prepare for the burn-outs by having the car on some side track near the repair shop, where it would not interfere with our running time or cause a hindering of cars, we would not feel so aggravated; but it happens invariably at the time we need every car most urgently. We can watch our gear and bearings, and when worn they may be replaced at our convenience or at night, but an armature gives out without warning. It is on this account that those systems advocating but one motor to a car must give us positive assurance of *no burn-outs*, for were it not for the double motor now so generally in use we would see crippled cars being *towed* into the shop greatly to our discomfiture. In the matter of minor details, such as cables, terminals, trolleys and gearing, the electric manufacturers have made the greatest improvements during the past eighteen months; but so far as we can obtain information based on actual facts, there has been but little improvement in the armatures. The Edison Company has recently announced a new armature, but we have been unable to learn what results it may show.

The switch-box, such as used by the Sprague-Edison and Westinghouse, is an apparatus that if given proper care, so as to keep the brass plates and buttons smooth, ought not to cause much trouble. It is arranged so as to distribute the current through different parts of the magnets or the motor according to the degree of speed or work required. It is somewhat in the way of passengers when the platform is overcrowded. The rheostat used by the Thomson-Houston Company is out of the way, being underneath the platform, although it is burnt out occasionally and damaged by rain leaking through the platform. These defects should be easily overcome. It is claimed that, owing to the use of the rheostat of the Thomson-Houston Company and the resistance coils as used by the Westinghouse Company, the cars start much more easily and without jerking, and that the motor is less liable to burn out, as they avoid throwing in an excess of current. The first claim is true, but we cannot find evidence to support the latter claim. On the other hand, it has been claimed that motors using a rheostat require on an average run from 15 to 20 per cent. more power than the Sprague-Edison motor. It does not necessarily follow that this is due to the rheostat; it seems likely that it is due as much to a difference in the winding of the armature or fields. It would be most desirable, therefore, to ascertain from our various members the actual number of burn-outs of field and armatures, of both varieties of motors, and at the same time the average power used per car. This cannot be obtained by writing for reports, as many roads do not keep an exact record, or will not report the same. The grades of roads must be considered, the car mileage, and loads carried, also the system or manner with which motors are required and cared for.

This is a matter of the greatest importance. Our fuel costs about $1 per car per diem, and our repairs over $1.50 per car per diem. If we can save 10 per cent. each day on fuel by giving up the rheostat we do not want to do it at the expense of adding 25 per cent. to our repair account which, we all know, is too large already. As an example of the approximate cost of repairs I give the cost of four 30 h. p. Sprague cars for the six months ending Oct. 1, 1890, each car making 90 miles a day, a grade 1,900 feet of 9 to 9¼ per cent., one 300 feet of 5 per cent., one 300 feet of 8 per cent.

MECHANICAL.

3 Bronze Intermediate Pinions, at $14	$42.00
3 Steel " " at $9	27.00
8 Steel Armature " at $7	56.00
4 Intermediate Gears, at $11	44.00
2 Main Gears (axle), at $16	32.00
6 Axle Brasses, at $4.50	27.00
8 Shaft Bearings, at $4.50	36.00
12 Armature Bearings, at $2.75	32.00
Total	$296.00

ELECTRICAL.

180 Carbon Brushes, at 10 cents	$18.00
6 Trolley Wheels, at $1.25	7.50
3 Field Magnets, at $20	60.00
6 Armatures repaired, at $35	210.00
	$295.50
For Labor:	
2 Motor repair men, at $50 per month	600.00
Total	$1,191.50

Average per diem per car, $1.62.

There are other minor repairs that would increase this about 20 cents a day.

Fuel, sawdust and slabs, $1.30.

This fuel is about equal to screening or slack at $1.50 a ton. A greater number of cars would reduce this fuel account per car. During the six months the expense on the overhead line was less than $25 on five miles of line.

We have learned of an eight-car road running at $1 per car for fuel, another six-car road at 90 cents per diem per car. We do not believe in any case that the fuel will equal the cost of motor repairs. The first year of operation must not be taken as a fair estimate. The prices for gear and bearing will vary considerably from those given above. Some axle brasses cost $9, while those above are given at $4.50. Aluminum or some such compound may be mixed and used to decrease the cost and increase the durability of bearings. It was sold a few years ago at $3 and upward per pound, now at $1, and it is stated can be produced for 20 cents per pound.

In the matter of gear the Westinghouse Company has so boxed the same that it can run in oil and grease; this must undoubtedly add much to the life of the gear and pinion, and at the same time practically deaden the noise. Whether this boxing will stand the wear and jar time will best demonstrate.

The following report of a road operating Thomson-Houston motors is most valuable in showing the proportion of cars disabled from electrical and mechanical causes. During 14 consecutive days in July, 1890:

Equipped.	Operated.	Disabled. Electrically.	Disabled. Mechanically.
286	150 to 200	0	15
286	150 to 200	0	12
286	150 to 200	2	12
286	150 to 200	5	8
286	150 to 200	0	11
286	150 to 200	3	11
286	150 to 200	3	9
286	150 to 200	1	10
286	150 to 200	5	7
286	150 to 200	2	11
286	150 to 200	2	15
286	150 to 200	2	13
286	150 to 200	1	12
286	150 to 200	0	12
		26	158

In seven consecutive days in August:

Equipped.	Operated.	Disabled. Electrically.	Disabled. Mechanically.
308	150	3	10
308	150	5	11
308	150	0	9
308	150	4	7
308	150	0	5
308	150	4	5
308	150	1	8
		17	55

During seven consecutive days in September:

Equipped.	Operated.	Disabled. Electrically.	Disabled. Mechanically.
312	150	2	3
312	150	5	3
312	150	3	2
312	150	3	3
312	150	0	5
312	150	1	4
312	150	1	4
		15	24

From this it appears that in July about one per cent. of cars operated were disabled each day from electrical causes, and about six per cent. from mechanical causes, and this during a period of extraordinary heavy business.

During the August period the electrical trouble appears to have increased slightly in excess of one per cent. and the mechanical decreased to about five per cent., and in September the mechanical trouble decreased to about two per cent. This decrease was probably due, in some degree, to a lighter business and less mileage. As the report does not state the nature or degree of the electrical disabilities, it is not fair to assume that they were all due to crippled armatures, but we can deduce from it that a car ought to run 100 days without electric repairs.

WILLIAM L. ALLEN, Committee.

October, 1890.

After the reading of the report, the association adjourned to meet in the evening in executive session. It is understood that at the meeting in the evening there was some discussion involving the cost of operation and repairs of electric railroads; but by request of the speakers the matter was not given for publication. The general testimony, however, did not vary much from the figures as given in the report above.

Mr. GEORGE W. MANSFIELD, of the Attleboro electric road, addressed the meeting as follows:

I came here, like many others, to listen and learn. I am a director in the road, and take a deep interest in its operation; but I cannot give you any specific and accurate figures in regard to the cost of operating the road, either for power or repairs to the motor. We hire our power, and are in one of those unpleasant predicaments that no doubt many other electric railroad men have found themselves in when they came to pay another concern for the power supplied to their cars. Some of these companies want from three to five dollars per day for the first three or four cars, and perhaps fall off fifty cents per car thereafter. I have even heard that one company wanted eight cents per car mile. I doubt not that in the East, and in a great many other places, they are paying in the neighborhood of from four to seven dollars on small roads of from four to seven cars, the cars making in the neighbordood of 100 to 120 miles a day. I do not know but that in some cases the electric light companies are warranted in making such a charge.

They may have to pay $4.50 or $5 a ton for coal; and I know that electric railway managers get all they can out of their electric cars. When an electric car has to climb a grade of eight or nine per cent., with perhaps 90 or 100 passengers on it, there is a pretty severe strain on the steam engine; and perhaps at the time it gets up, or half way, something necessitates the current being cut off and the brakes applied and then the car starts again under these conditions. The indication of the steam engine on one car under these conditions has run as high as 71 or 72 h. p. In Albany, on the Capitol Hill, they stop half way up the grade, about an eight per cent., and they have very heavy traffic, too. In a general way it has been my experience that the cost of operating an electric car per mile, and the mileage being in the neighborhood of 110 miles, not to exceed 120 or fall below 90, perhaps—I make that provision since I know of some roads running as high as 160 miles, which is an excessive duty to impose on the car; but if the manager of the car permits it and he has to pay 10 cents per car mile on repairs it is nothing more than he ought to do—I say in the neighborhood of 110 miles, and, under average conditions, perhaps grades of 5 per cent. I think that in a great many cases under these conditions, counting simply the maintenance expenses, meaning the oiler, wipers or cleaners, grease, repairs to all of the electric apparatus on the cars, including even the truck, and not including any fixed charges or anything of that kind at all, the cost of operation can be reduced to the neighborhood, on large roads, of about three cents per car mile. On small roads it costs more, perhaps four or four and a half. The whole matter is very largely a question of brains on the part of the managers of electric roads; and so far as my observation goes, there is somewhat of a want in that direction. By brains, I mean an intelligent mechanical inspection of the car and maintenance of the electrical apparatus. On this account largely it is difficult for any man to give at this time any accurate figures in regard to both the operating expenses and repairs of cars and at the station that would be applicable to all roads.

Mr. R. J. MCCARTY, superintendent of the Metropolitan Street Railway Company of Kansas City, read a paper and spoke at considerable length on the comparative cost of operation of horse, electric and cable roads. His statistics showed that the cost of operation of a 10-car road would be the same by electricity or horses; that when the number of cars was above 10, the road could be operated more economically by electricity; and that when the number reached 50 cars and upward, he considered the cable to be the most reliable and economic.

The meeting on Thursday morning was, on motion, open to all interested, and a special committee was appointed to apprise the representatives of the different electrical systems that an opportunity would be afforded them to address the meeting.

Mr. D. H. BATES, vice-president of the Accumulator Company, took the floor, and, after thanking the association for the opportunity given him for presenting the subject, read the following paper:

THE EDCO STORAGE BATTERY STREET CAR.

The horse is a noble and extremely useful animal, but he seldom combines high speed with great endurance. The fast trotter is made to run his mile in from two and a quarter to three minutes, but he does it only on rare occasions and is well fed and cared for between times. It was not until yesterday, when Mr. Odell's very interesting paper was read, that I had any idea of the innumerable obstacles to be surmounted in, first, securing a perfect street car horse and, second, in maintaining him in a constantly efficient condition.

Judging from the expressions of a large number of street car men with whom I have talked on the subject of storage battery cars, I have inferred that your street car horse was ready for continuous hard work at all hours of the day or night, that it took no time to change horses at the end of a trip, and that you only fed them at night after a sixty mile run, and that oats and hay were always cheap; for all these or like requirements must be met in our storage batteries, if they are to satisfy the average street car official. But when we undertake to show that the energy requisite to propel a 16-foot car with its average load of passengers at the horse car rate of speed must be increased 100 per cent. if the speed be doubled and that the cost of producing that increased energy by whatever means you employ must necessarily be doubled, the scientific fact is perhaps admitted; but if storage batteries are the medium, it is always taken for granted that they ought to do double the service at half the cost.

The overhead systems in operation throughout the country have demonstrated to you, gentlemen, the fact that electricity is not the coming power, but the power already come. The mileage of street roads in the United States which in June, 1890, were operated electrically is, according to the Eleventh Census, 8.26 per cent. of the entire mileage, but omitting 59 cities the proportion runs up to 25 per cent. This means one of two things, either that as a rule the authorities of our large cities will not allow overhead poles in the street, or that street car managers prefer to await the result from the use of the electric system on a small scale in the towns and smaller cities before introducing it in the cities on a scale of greater magnitude.

The overhead systems already introduced in many places have so far improved upon the horse and mule that the public, once given rapid transit, would not go back to slower methods, and are clamoring everywhere for such facilities. You street car owners and representatives, however, must look at the resultant in the matter of cost per car mile and net profits, and before some of you yield to the loud demands of the public for rapid transit by adopting the overhead system we beg of you to carefully consider the merits of the storage battery.

It will propel a car just as fast and just as efficiently with all that that implies as the trolley system. Every word that can be said in favor of the trolley system applies equally to the storage battery. A storage battery car is capable of much work that a trolley car cannot accomplish. Storage battery cars can be introduced gradually one or two at a time in connection with horse cars, cable cars or trolley cars. We have already had proposals from a cable road for a few cars to be run at night when the cable could only run at a great proportionate expense, and from a trolley road where an extension was needed on a route that did not permit of trolley poles. Storage battery cars can be run over any track or route where a horse car can be run, thus avoiding blocks in cases of fires, processions and other obstructions. Transfers of cars can with this system be made from one road or route to another in cases of necessity or convenience in handling an unusual traffic. In cases of break down at power station during hours of heavy traffic, storage battery cars could run for two or three hours with the 33⅓ per cent. reserve always remaining in the double set of batteries.

Now, as to the figures relating to the battery system: What is the cost of a storage battery car plant? What does it cost per car mile to maintain? What does it cost per car mile to operate? Let us take a unit of 50 cars.

Fifty cars at $1,000, $50,000; storage plant engine, nominally 500 h. p. (triple expansion), $12,500; 500 nominal h. p. boilers, 50 per cent. margin, $10,000; 50 sets of car motor equipments, each consisting of two 15 h. p. slow speed motors capable of being exerted up to 20 h. p. each for brief periods, with dust tight covers, gearing and motors running in oil, starting, regulating, reversing and speed switches, lamps, signals, batteries, etc., complete $249.400. Central station equipment, including dynamos, rheostats, switches, reserve batteries, shifting appliances, etc., complete, $128,400; grand total, $450,300—say $9,000 per car for everything except buildings, road-bed and tracks.

MAINTENANCE PER ANNUM.

Steam plant, 10 per cent	$2,250
Cars, 10 per cent	5,000
Electric plant, exclusive of batteries, 10 per cent	21,500
Batteries, 20 per cent	31,680
Shifting appliances, 5 per cent	200
Total maintenance per annum	$60,630
Maintenance per car per annum	$1,212.00
Maintenance per car day	3.32

Maintenance per car mile (on basis of 120 miles per day), 2¾ cents.

With a smaller run the wear and tear would of course be reduced.

DATA OF POWER PLANT AND COST.

Horse power required	500
Time required for producing such power	18 hours
Total horse power hours	9,000
Coal per horse power, with triple expansion engine	2 lbs.
Coal per day	18,000 lbs.
Coal, being estimated at $8 per ton	$27.00

LABOR.

One chief engineer	$4 00
Two assistants at $2.50	5.00
Two firemen at $2	4.00
Two assistants at $1.50	3.00
Six shifters at $1.50	9.00
One electrician	4.00
Two assistants at $2.50	5.00
One dynamo man	3.00
Total labor	$37.00

SUPPLIES.

Water per day	$5.00
Oil and waste	2.80
Appurtenances and miscellaneous	2.80
Total supplies	$10.60

RECAPITULATION AND SUMMARY.

Fuel per day	$27.00
Labor per day	37.00
Supplies per day	10.60
Total cost per day for operation	74.00
Cost per car day for operation	1.48
Cost per car mile for operation	1 24-100 cents.
Cost of maintenance per car mile	2 75-100 cents.
Total cost of maintenance and operation per car mile	3 99-100 cents.

The following are some of the conditions fulfilled by this company with its storage battery cars.

1st. That each car will be delivered in first class order with appliances for keeping it well under control and for readily operating it with such skill as would be possessed by an intelligent car driver after suitable instruction.

2d. That each car will be run 15 miles an hour on a straight level and suitable track in good order when carrying 50 passengers, or an equivalent weight not exceeding 6,000 pounds.

3d. That each car with the above load will ascend grades not exceeding five per cent. and not longer than 500 feet at the rate of at least five miles an hour.

4th. That two sets of batteries per car shall be delivered, either of which when fully charged shall be capable of propelling a loaded car as above on a straight level and suitable track for a distance of 60 miles if required, when it shall be replaced by the reserve battery, which meanwhile shall have been fully charged. Each battery can be charged while its alternate is being used. As a matter of policy, we advise retaining one-third of the charge of the battery as a reserve for emergencies.

5th. That the batteries when treated according to printed instructions and their parts renewed as required will remain in an efficient condition.

We have already touched upon some points of advantage in the storage battery traction over the trolley system. We will now refer to the inherent defects of the trolley system which do not pertain to storage traction.

1st. The disfigurement of streets by double lines of poles and trolley wires, with cobwebs at every curve.

2d. The frequent interruption of the entire system by a break-down at the power station or in the feeder wires.

3d. The great and sudden fluctuations in the load which make such break-downs of the power plant extremely frequent, many such break-downs having already occurred. With trolley and cable lines, the extremes of no load and full load are reached suddenly from one to a dozen times every five minutes. This is not only destructive to the machinery (steam, electric and cable), but frequently causes a break-down of the whole line, involving heavy outlays for repairs, serious loss of revenue and dissatisfaction on the part of the public.

4th. Bad economy in the power station, due to the fact that maximum power must be provided in the engines and dynamos instead of the average power as provided in the storage system, causing the engines with the trolley system to run with an average of about half their load, and therefore uneconomically; with storage battery traction the engines and dynamos run with an even and unfluctuating load continuously, giving the best possible economy of coal and increasing the life of the plant. Economy and inconvenience of operation as compared with requiring an expenditure of energy in all portions of the line, even though but one or a few cars may be running. For suburban roads and all-night runs this feature is of special importance.

5th. Liability of generators and motors being burned out by lightning passing through the bare trolley wires through the motors to the ground.

6th. Liability to motors burning out with the high voltage current.

7th. The business public is inconvenienced by the derangement of the telephone service due to induction and leakage from the trolley lines to such an extent as to make the telephone service useless and dangerous.

Last, and perhaps most important, at least to the general public, the trolley system requires a current of high potential conducted along bare wires extending over the entire route of the line, always liable to contact with electric light, telegraph, telephone, district messenger, fire alarm and police alarm wires, the system thus being a constant menace to life and property throughout the city. Contact with any foreign wire may lead to a conflagration such as destroyed immense values of property in Lynn and Boston within a year, and death to horses and human beings, numerous instances of both having been frequently reported in the public prints.

Therefore we feel warranted in asking street car companies to give storage battery traction, which possess none of th se disadvantages, and involves none of these dangers, a fair trial under reasonable conditions, and under the supervision of men experienced in the various branches of engineering involved in the business, and who have had nine years' experience in the manufacture and use of storage batteries.

Mr. Richardson, of Brooklyn: I understood the gentleman to say that the storage battery car could run 15 miles an hour for four hours, and that it takes as long to charge the battery as it does for the battery to work.

Mr. Bates: You are correct.

Mr. Richardson: There lies my great doubt as to its practicability in a road that wants to run 50 cars three minutes apart.

Mr. Bates: By a suitable provision of alternate batteries that is accomplished easily. One of our cars has been in daily operation in Dubuque for 60 days, and we are now equipping the road with six cars.

Mr. Richardson: How long does it require to take out one set of batteries and substitute another?

Mr. Bates: It depends largely upon the skilfulness of the men employed; from one and a half to three minutes.

Mr. Richardson: What do you base your calculations upon as stated in your remarks; from actual figures that you have, or are they an approximation?

Mr. Bates: From figures which we have very carefully prepared, and which are approximately correct, based upon 10,000 miles of service with our three cars.

Mr. McCarty, of Kansas City: How many horse power per car is required?

Mr. Bates: It depends upon the number of motors we put out: 10 h. p. is about the amount of steam plant we require per car.

Mr. A. H. Chadbourne, of the Wenstrom Company, was the next speaker. He said:

Nearly every year there is brought to you something new in this line. This year we come before you with something that is a novelty. I think it is generally acknowledged that it is desirable to have a slow speed armature in a street car motor, and that the motor should be reduced in weight as much as possible, and if possible a device provided whereby the armature could be allowed to run free at all times without relation to the car speed. We accomplish these results in a very satisfactory way. We expected to have had a car in operation here, but, owing to delays at our factory, have not been able to do so. We have a cast of our field magnets here. It is cast solid. The machine is 25 h. p. The fields are cast in one solid piece of mitis metal. The speed of the armature is 400 revolutions a minute, developing 25 h. p. The metal is cast in such a way that it has nearly the same properties as wrought iron, and has the advantage that it can be welded. The wires, instead of running over the periphery of the armature, run through it, and the external portion is turned down true, so that it presents a plain surface. The advantage of this is that it is impossible to have the wires spread or thrown apart. Another feature of the motor is the method of connecting the wires on the commutator. Sometimes there is a great deal of trouble with these connections by reason of the solder melting. We have no road in operation yet, but will have one in operation at Pottsville, Pa., by the first week in November. We also expect to have a motor in operation in Baltimore very shortly. Our construction is not unlike that of other companies in its detail, the overhead arrangement of wires being the same. You know what the trolleys are. The generator is unlike those with which you are familiar. It is a machine that works at slow speed. We also have a patent connection between the armature and the commutator. It runs at 425 revolutions per minute, developing 67½ h. p., running perfectly cool. A peculiar feature is that the construction is such that they utilize to a greater extent than any other machine the magnetic qualities which are generated in it. Another point is the gearing. You are all familiar with the ordinary gearing. We have a gearing which we are prepared to put under any system. It is an inexpensive gearing, and is economical to operate. It is a gearing with wooden teeth, and has a removable rim, which is absolutely noiseless; and we have reduced the point of wear to the cheapest part of the gear, the teeth. No matter how small the accident, if one of the teeth breaks, the gear is gone. There is no reason why our gear should ever break, and the wooden teeth will last anywhere from four to six months, in accordance with the work. In Atlantic City they ran all summer long. The manager there stated that the gears had done excellent service. We use this gear on our system, and will put it on any other. Another point is that, owing to the slow speed, we do away with the intermediate countershaft, and, consequently, that does away with two bearings and two gears. We gear direct from the armature to the car axle. There is another feature worthy of your attention, and that is the method by which we allow the armature to run at full speed at all times. The armature is started up and the gear runs freely; the rim revolves freely around the axle, and is connected to it by a system of hydraulic gearing. It is by the operation of the oil in the gear that we get the difference of speed in the armature and car axle. The oil is forced up from one part to another, and when the valve is open the rim will run free. If the valve is half way open you will get a variation of speed.

Mr. Henry, of Pittsburgh: Do you propose in that machine to do away with the intermediate gearing entirely?

Mr. Chadbourne: Yes, sir.

Mr. Henry: In that way you get rid of one-half the machine under the car?

Mr. Chadbourne: Yes, sir. We do away with a large factor in repairs. It is the high speed of the street car motor that makes the trouble with the gearing. If your intermediate gear only ran 125 revolutions, it would be a very simple matter to keep the gears on. In a slow speed machine much of this trouble is overcome, and it is acknowledged to be a very desirable thing.

Mr. Malone Wheless, of the Wheless Electric Company, next addressed the meeting. He said:

We have a system in Washington that differs in no respect from the other systems, except that we carry our cars by an underground cable. It extends the whole length of the road and feeds from the sections, which are laid in the conduit, and laid in the usual way. The sections of the conduit are carried along, and at every 300 feet, more or less, as occasion requires, switch boxes are put in. This is about 16 inches square and laid between the tracks in double track, or between the rail and slot rail for single track roads. The object of these switch boxes is that when the car comes along they automatically connect the current in the cable with a given section. Suppose we have a mile of road; there is a mile of cable laid by the side of the track. From that cable at every 300 feet is laid a feeder that feeds one insulated section of conduit wire. The conduit wire is at all times dead; there is no current in it. The current at all times is in the cable, and when the car comes on to a section a device attached to the car acts in conjunction with the switch-box, and the result is the connection is made from the cable to the wire in the conduit. The car instantly receives the current and passes over that section and on to the next, when the passage of the car off the section releases the armature in the switch box, and as a consequence the section is cut out. The reason of "cutting in" is because putting a continuous conductor in a conduit has been found inexpedient for two reasons. The first is the escape. I believe it is impossible to take a continuous conductor and transport it through five or six miles of conduit and not have such an escape, no matter how well insulated; that the efficiency of the motor is materially and seriously impaired when you get a long distance from the generator plant. The other reason is the liability to short circuit. The advantage, we found in cutting our wire in sections, was that only a certain section was charged with current, and consequently a short circuit could only occur at the point where the car was. This constitutes about what our underground system is; it is simple, and does not exceed in cost the ordinary conduit, or costs very little more. Our overhead system is a duplicate of the main feature of our conduit system. We feed in sections. The overhead line is dead at all times, and there is no way in which a person can receive a shock from it. I shall be glad if gentlemen present would come to Washington and see our system.

The remarks of Mr. Knight Neftel, of the United Electric Traction Company, of New York, were as follows:

It is unnecessary for me to say anything regarding the value of storage battery traction, after the very apt remarks made by my friend of the Accumulator Company. I will simply give concisely our results in operating ten storage battery cars on the Madison avenue line in New York.

The equipment of each car consists of 108 Julien cells in 12 trays, nine cells in each, with a total weight of 3,600 pounds. The motors in use until recently, and on the old cars now running, are of the Thomson-Houston type. We have now constructed a motor especially adapted to this class of work, and which is now being put on this line. An estimate of cost of operating has been submitted to you by another company, based on the performance of 50 cars. Our experience with ten cars in actual operation over an extended period, which, by the way, is the largest storage plant in this country, and next to the largest in the world, is as follows:

Generating plant, 8 h. p. per car. For ten cars 15 batteries are necessary. Rate at which each battery is charged, one and one-half hours, for two hours' discharge. One charge is adequate for a run of 40 miles and a level track. With the old cells and the old type of motor these ten cars were operated with 10.61 cents per car mile. The life of the existing plates of the battery, at the present rate of disintegration, is at least three years. The negative plates, the other half of the battery, are as durable as the motor. It is generally conceded that the reason storage batteries have not been applied more extensively is lack of confidence in the endurance of the batteries and litigation on patents.

We are prepared to demonstrate to you practically the life of the batteries, and the question of patents has been greatly cleared by the final decree, giving Chas. F. Brush, of Cleveland, a fundamental award of priority.

Our batteries are manufactured under the patents of Brush, Julien, Morris, Salome, and others. We are now equipping a road in Indianapolis, Ind., on this system. Our company also furnishes overhead equipments, and we shall be pleased to have any member of the convention visit the plant at Madison avenue and the other roads equipped by us.

Mr. Graham, of Baltimore: Can you tell me the number of miles per day each car runs?

Mr. Neftel: Eighty.

Mr. Graham: The maximum grade?

Mr. Neftel: The maximum grade is about five and a half or six per cent; there is a very severe grade for a short distance on one part of the road, between Seventy-second and Seventieth streets, going down.

Mr. Graham: What is the length of the grade?

Mr. Neftel: About two blocks.

Mr. Graham: Do you ever run on a grade higher than five and a half per cent.?

Mr. Neftel: Yes, sir; there is one grade which is 7½ per cent. The motors will go up that, but, of course, it discharges the batteries very rapidly when you subject them to such heavy work.

Mr. Graham: Is the car capable of ascending any usual grade, say 10 per cent.?

Mr. Neftel: Yes, sir; it is simply a question of discharging the batteries.

Mr. Henry: When you say 10 cents per car mile, what is included?"

Mr. Neftel: Everything except the conductors and drivers. Of course, there is a reasonable amount for the repairs of the motors.

Mr. A. T. Potter, of the Short and Brush Electric Railway companies, next addressed the meeting. He said:

The Brush Company, as you know, has been in the business of building dynamo machines and electric batteries for many years, being the pioneers among the pioneers of that business in the world. We have been building dynamos since 1876. We have recognized that the electric street railway work is the severest to which the dynamo machine has ever been subjected; and in starting out in our electric work we aimed, as no doubt all others have aimed, to build a dynamo machine that would stand the rough work, with as few failures by stoppage as possible, and in the next place to make the delays incident to such stoppage as brief as possible and the repair work as simple and inexpensive as possible. We claim that with our motor we have reached a high point of perfection in these respects. The difference in our motor is mainly in the type of armature, where we use a ring instead of the usual drum type of armature. There are many advantages that we obtain by the use of this type of armature. The bobbins or sections of the armature are all independent, and in case of any burn-out or trouble it would be confined to a single bobbin. Again, we get a very great diameter of armature as compared with others, and are enabled to use larger pinions and save greatly in wear. As a matter of fact, since the beginning of the present year we have never burnt out a field magnet or armature coil in actual service. This will be confirmed by any road operating our system. The favor it has met with and the large number of orders we are taking speak loudest in praise of the system. Another feature is the insulation of the motor entirely from the framework of the car and from the ground. We think this is a great advantage. We believe that a great deal of the expense and trouble is due to the grounding of the motor, the bursting through and burning out of amatures, fields and commutators. This insulation is carried to the gears. We make them with an insulated web to deaden sound, and use steel pinions and steel gears, steel axle gears, and overcome the noise at the same time.

Mr. W. J. Carruthers-Wain, President of the Tramways Institute of Great Britain and Ireland, was next called upon. He said:

I came to this country with the hope of learning as much as I could about electric traction in America. What I and most people want to know, is the item of depreciation and repairs; in other words, repairs and renewals, and the amount to be set aside as an annual sinking fund for the question of depreciation, which must enevitably ensue. It has struck me, not only in this assembly, but in many others, that figures, after all, are rather delusive. Electricity came under my observation this way. I was satisfied that no man was suited with the system of tramway traction in Europe up to within the last three or four years. We had leased a line from the Birmingham authorities,

with the proviso that it should be operated by cable; but there was not enough of business to make that system profitable. Electricity appeared to be the only visible motive power; and in November, 1888, there was tried upon the Birmingham Central Tramways a self-contained electric motor, which was designed upon the Julien system by Mr. Thomas Parker, of the then Messrs. Elwell, Parker, Limited, and myself.

The directors of the Birmingham Central Tramways Company permitted the experiments to be conducted upon their lines, upon condition that the electric motor to be used should be in the form of an engine, insisting that, before they would consider the question of electricity at all in connection with their lines, they must be convinced by actual demonstration that the power was as great, if not in excess, of their most powerful steam engines then in use, and when I point out that they are some 12 tons in weight, having cylinders nine inches in diameter, and carrying a pressure of 175 pounds to the square inch, you will agree it was no small task to attempt. However, upon actual trial, the electric motor, although weighing only nine tons, when coupled to one of the steam engines, hauled the steam engine in spite of the fact that steam was full on and pulling against the electric motor. We afterwards started and hauled with the electric car a load of some 30 tons up a grade of 1 in 32. We have also run with one charge of the accumulators 70 miles, hauling a car which, together with the load contained therein, weighed over six tons, and this on a very heavy grade of tramway, traveling up a grade of 1 in 19 over 500 yards in length during the day 10 times. This electric car has been so successfully run over their heaviest steam route, and given such satisfaction to the directors, that they gave an order for 12 electric cars, which have just completed what is undoubtedly the finest installation of its kind in the world.

The car is made to run upon a 3-foot 6-inch gauge, and is constructed to carry 50 passengers, 24 inside and 26 outside. It measures over all in length 26 feet, and in breadth 6 feet 3 inches, and from floor to roof 3 feet 6 inches. The sole or foundation of the car body is made of channel iron, strutted so as to give it great strength and rigidity. The car body is carried upon two bogies of the ordinary kind, and the motor is geared to the axles of one bogie by a train of helical gearing. The accumulators are placed in trays, each tray containing eight cells, and these are carried under the seats of the car, the outer panels of which slide up behind the seats so as to admit of their being readily placed in position. The connections are so arranged that contact is made automatically as the trays are pushed into position. The whole forms four batteries. The switches are of the Julien type, and the car can be driven from either end. They are so constructed that the cells can be equalized and the batteries used either in parallel or series. The car, motor and batteries weigh nine tons, as against the steam engine and car's 16½ tons, a large saving in dead load to be hauled. The work of charging the accumulators is reduced to a minimum by having a specially arranged balanced lift or elevator. These work in pairs, one balancing the other. Each shelf is fitted with automatic connections, and is in every respect an exact duplicate of the car, so that when the accumulator trays are drawn thereon automatic connection is made, and the cells are charged whilst in position without again being moved.

Mr. Richardson: How many cars are you running?

Mr. Wain: We have 12 altogether, but are only running five. I may say as a point of interest that during the time that line was under construction we worked it first by a system of horse tramways, and the average takings were about $750 a week. During the time the electric road was in process of construction the receipts on the horse line were reduced to $600 a week. Immediately the electric cars were put on, the takings jumped up to $1,250 a week. This was not due to any additional service, because it is precisely the same; not to any increase in population, because it has not grown so rapidly, but simply to the fact that we have been able to put on in place of the wearisome horse car a comfortable car moving by electric power.

Mr. Henry: How often have you renewed the plates?

Mr. Wain: We have not renewed them at all. We expect to get a life out of our plates of six months. The question of profit on the workings of the storage battery is not a matter of speculation, but is a matter of dead certainty. Inasmuch as there are several gentlemen here connected with overhead systems, I should like to say I believe there is room for all, certainly in America, if not in England.

Mr. Henry: Do you reconstruct the horse track for the electric road?

Mr. Wain: It was reconstructed; but not solely for that reason. The road was very much dilapidated.

Mr. Henry: What percentage of loss in efficiency in the motor is there?

Mr. Wain: I am not going to give you that, because three months' work is not sufficient time in which to give a general test. I understand as nearly as possible we get 50 per cent. on the wheels.

Mr. E. E. Higgins, of the Edison General Electric Company, next took the floor. He said:

The Edison Company, with its accustomed modesty, desires to say that it has the best electric system in the world. The reason is twofold. In the first place, as you are no doubt aware, it is acknowledged that the Edison motor will consume less coal. This is an important point, and has bearings in many directions. If we can operate 100 cars with 750 h. p. as an average output, it means that we can have less dynamos, less engines, less boilers and less apparatus in general than can be done with a system which requires 1,000 or 1,200 h. p. to operate the same number of cars. The cost of investment is less, and of course the interest is less. That is one advantage, and in addition the coal bill is much less. Another difference would be the depreciation. We believe that the depreciation per passenger carried with our system can be made out less than with any other. We do not claim that it has been less in the past, although not greater. We have the best roads in the country; perhaps we have some of the poorest. It is a question of management and lies directly with you, gentlemen, as to the success of electric traction. In most cases the motors do not receive the attention that would be given to an ordinary steam engine; and if you run them successively for 150 miles a day, and do not lay them up and treat them with care, you cannot expect that your armatures will not burn out and other troubles ensue.

In the new apparatus that we are bringing out, we have made some very notable advances. In the first place, our armatures are wound upon an entirely new plan, one which we think is a distinct advance. In the old style what is known as the Siemens winding is employed; the wires are wound on the core and carried around at the end and form a conical-shaped bundle, which gives a chance for play and abrasion, and this means short circuits and burn-outs. With the new armatures we have a new standard coil, some sixty of which go on to the core. They are so formed that the rear of the armature, and front alike, give no chance for motion. They are brought firmly in place, and you have a diameter of armature which is always the same, because the coils are standard. With this system burn-outs will be extremely rare. We do not claim that there will not be any; but we believe in the regular daily workings of the car, with proper management, nothing ordinary will burn out the machine, except dead overloading. When it is burned out it can be replaced by any mechanic. The switches are on a little different plan. We have avoided the difficulty which has sometimes occurred of starting the car too suddenly, but which with careful management could always be prevented. We make it impossible to start suddenly by putting in a slow starting device, which starts the car gradually and effects a saving of power. It is not a rheostat. We are the only company that uses commutated field coils. We believe in them; we do not believe in the rheostat. You all know about our dynamos. The reason of their success is that they are a development and not an invention. Their efficiency is over 90 per cent. in the ordinary sizes, such as employed on street railroads. In some cases it is higher. One reason for their success is that the moving parts and centre of gravity are near the floor. The line construction of the company is acknowledged to be standard in respect to simplicity, neatness and cost. We use the feeder system. That is a system of wiring in which the electricity is delivered at regular intervals of a few hundred feet into a trolley wire. This results in the fact that the electricity is delivered to a large mesh-work of conductors in such a way that at every point in these conductors the pressure will be uniform.

Mr. E. H. Johnson, of the Interior Conduit and Insulation Company, said:

I do not propose to occupy your time, but only desire to call your attention to the fact that the gradual development of the overhead electric system has become such that in many of the larger cities it is now becoming imperative that the conductor should be placed underground. In a city where 50 to 100 cars are operated, there is at least 95 per cent. of the wire on poles overhead which may with advantage to the company be placed underground. It is not necessary to have them overhead. The trolley wire being the only thing that is necessary to have overhead, it follows that all the feeder wires, special mains, etc., may be placed underground. The question is, Can the wires be placed underground with less investment, and can the insulation of the wires be maintained underground with less charge for repairs, and if so, how? Our company is prepared to lay down the wires underground and guarantee their efficiency for a number of years. Until it is rendered commercially successful, I propose to put the feeder wires underground, leaving the trolley wire overhead. The tubes are paper, treated with special asphaltic compound to render them insulated and placed in a trench, and then filled with the insulating compound.

Mr. George W. Mansfield, representing the Thomson-Houston Company, said:

As all the other companies have been represented, I suppose the Thomson-Houston Company ought to be also. I do not know that I can say anything in particular about our system, since it is the most generally used and must be most generally known. We first started in the business with the feeling that the thing we had to do, above everything else, was to make as big a difference between the net receipts and the gross receipts of the company that purchased our apparatus as possible. We recognized the exigencies of the moment, and knew that we had to put our apparatus in the hands of men who were untechnical and were unskilled, and who knew nothing whatever about mechanics and electricity. We felt, therefore, that we had to build additionally strong to meet that necessity. We have put out in the neighborhood of 3,500 motors. I think they are nearly all running. The first motors we put out are in operation to-day, and gears, armatures, spools and the various parts constituting the motor that are built to-day can be used with the motors first put out. We feel that we have planned on the correct principle. I want to make an appeal to you, gentlemen, much in the same vein as my predecessor, Mr. Higgins. That is, regarding the management of the electric apparatus. If there is any one thing that has injured the business in the eyes of the public, who are not interested in electric roads, it is in many instances lack of management on the part of the railway companies that are operating the electrical apparatus. Many roads are a disgrace to the directors and every one connected with the company, because the motors are kept in a dirty condition. They are not handled by men who have the requisite skill and intelligence. Any one knows if a steam engine is not taken care of it goes to pieces; and the same is quite as true of electric motors. The railroads should employ men of skill and brains and intelligence to look after these mechanical and these electrical details; and the more information, the more knowledge they have, the better they will perform their work.

In regard to new apparatus, we are constantly improving all our details. We are making the motor stronger wherever experience has dictated it to be necessary, and we are making it lighter wherever it is necessary. We are improving each detail of the entire apparatus and increasing efficiencies, so that in a very short time we will have the most complete system. Our switches at each end of the car are under the hood of the car, so that in case of any accident or any trouble the conductor at the rear end can cut the circuit either with his switch or by pulling a trolley wire down, and the driver also has that facility. We have a fuse-box on our car, and it is a very simple matter to replace a fuse if the driver has been careless or ignorant or unskilled, and turns his current too quickly on. That operates as a check against the man as well, as record can be kept of the number of fuses used. We have a lightning arrester, which we claim is the only one of practical value. As to our motors, we build 10, 15 and 20 h. p. of one type, and the same power of another type, so that we can use our motors either single or double upon trucks of any gauge from three feet three inches up to six feet. If the railroad men would get down to a uniform gauge it would help us out very much. As to station apparatus, our dynamo has an efficiency of over 90 per cent. It will pull through more hard raps and do more service in a given space of time than any other. In our new work we are pushing ahead and building dynamos up to 240 and 250 h. p., and directly coupled to engines also. We are building heavy motors for excessive work and for tow work, and we are going into all sorts of devices and experiments in regard to constant speed motors and slow speed motors. We want to be sure first that any new thing is far superior to what we have before we put it before the public.

Mr. Richardson: What is your expectation as to having something better in the near future?

Mr. Mansfield: I do not know exactly how to answer your question; but I do not think the electrical appliances will improve more than 15 or 20 per cent. for many years to come.

Mr. Richardson: You cannot promise anything in the next six months?

Mr. Mansfield: No, sir.

In addition to the subject of electricity, the association considered the following subjects, special reports having been presented thereon: "Perfect Street Railway Horse," "Novel Schemes for the Development of Street Railways," "Public and State Treatment of Corporations," "Spiral or Transition Curves for Street Railroads Operated by Mechanical Motors."

The association had its annual banquet on Thursday evening, and on Friday the delegates accompanied by their wives and daughters and all the gentlemen interested in the association, including non-delegates, were taken by special train to Niagara Falls, by courtesy of the Buffalo street railroad companies.

Before the association adjourned the following officers were elected: Henry M. Watson, Buffalo, N. Y., president; W. A. Smith, Omaha, Neb., vice-president; Charles Odell, Newburyport, Mass., second vice-president; A. D. Rogers, Columbus, O., third vice-president; Wm. J. Richardson, Brooklyn, N. Y., secretary and treasurer. The executive committee is as follows: Thomas Lowry, Minneapolis, Minn.; D. F. Henry, Pittsburgh, Pa.; Albert E. Thornton, Atlanta, Ga.; H. M. Littell, Cincinnati, O.; Thomas C. Keefer, Ottawa, Canada. The next meeting of the association will be held in Pittsburgh, Pa., the third Wednesday in October, 1891.

CONVENTION NOTES.

Charles Beach, of Albany, was exhibiting models of his automatic switch for motor cars.

Mr. C. E. Newton, of the Jewell Belting Company of Hartford, Conn., talked belting as he alone can do.

C. S. Van Nuis exhibited a capital collection of Ajax simple, double and treble pole switches in Arcade Hall.

The E. S. Greeley & Co. were upheld by Mr. F. A. Magee, who was looking out for their street railway specialties.

The New York Insulated Wire Company exhibited a fine line of samples of Grimshaw wire, both at the hotel and in Arcade Hall.

Mr. M. E. Baird explained the merits of the Eddy motor and exhibited some choice testimonials from the managers of present installations.

A neat display of standard wires was made by J. A. Roebling's Sons Co., who were ably represented by Mr. F. H. Perrine and Mr. G. C. Bailey.

The New York Indurated Fibre Pipe Company was represented by Mr. G. C. Collingwood, with a large variety of samples of very valuable product.

The Connecticut Motor Company sold the 1½ h. p. motor which it had on exhibition at the convention to the People's Railway Company of St. Joseph, Mo.

The Steam Gauge & Lantern Company, of Syracuse, showed, through Mr. Sawyer, full-sized models of their new electric headlights for street cars.

The thanks of the newspaper men are certainly due to Mr. J. H. McGraw, editor of the *Street Railway Journal*, for valuable assistance and courtesies shown them.

The Berlin Iron Bridge Company, represented by Mr. G. M. Harding, showed a large collection of photographs of car houses and the like equipped with their iron roofs.

One of the many good points about the Iroquois House was its excellent electric plant, which furnished ample power for electric lighting displays and the exhibition of motors.

Mr. A. L. Daniels, of the Eureka Tempered Copper Company, of North East, Pa., made a beautiful display of the company's specialties mounted on a black walnut background.

The Collett Car Brake Co., of Boston, was showing its quick-working ratchet brake for electric cars, which in construction and arrangement possesses some unusual features.

The Woodward Electrical Company, of Detroit, was fully represented and was distributing a few cold facts concerning the merits of the Detroit storage battery for street car propulsion.

The Detroit Electrical Works, whose interests were amply looked after by Messrs. Rae, Bossart and Jackson, exhibited a working model of their 30 h. p. street car motor in the hotel parlor.

The Tripp electric truck was on exhibition in connection with the Edco Accumulator Company's Car, of Philadel

phia, and excited much interest and did its work in a perfect manner.

The Buffalo Belting Works made an elaborate display of their specialties, including a large 48-inch double belt, which will be used by the Brush Electric Light Company of Cincinnati.

Gould & Watson, of New York, represented by Mr. R. B. Pierrepont, showed in Arcade Hall a large line of their molded mica insulators in the various forms useful for railway work.

R. B. Pierrepont, of the Gould & Watson Company, Boston, showed a full line of samples of their goods. A new clip wire holder which does not require a spring attracted special attention.

The Okonite Company had an extended exhibit of its wires in Arcade Hall, and its interests were upheld by Mr. McCoubray, who appeared at this convention in his new rôle of the great wirist.

Emmet Brothers, of New York, had their excellent line of street railway specialties on exhibition at Arcade Hall. They are one of the few firms making a specialty of novelties in electric railway supplies.

Mr. Neftel, who ably represented the United Electric Traction Company, of New York, was on the warpath, and made a telling speech before the convention in favor of the appliances of his company.

The Wightman Electrical Supply Company, represented by Mr. M. J. Wightman, exhibited some interesting samples of a new trolley wire insulator which should prove attractive to the street railway men.

Mr. R. T. White, of Boston, was upholding the merits of his familiar girder rails to the street railway delegates present, many of whom, however, were already well acquainted with the merits of his well known construction.

The wire men were out in force. Dr. Mason, who had just returned from an extensive and successful Western trip, was on hand to uphold the merits of the Simplex wire, for which he has recently been receiving large orders.

The Wheless Electric Railway Company, of Washington, was represented by Mr. Wheless himself and others. Some neat models and an elaborate catalogue showing the details of construction of that very ingenious system gave a clear idea of its merits.

The North American Construction Company, of Pittsburgh, Pa., has a fine exhibit in Arcade Hall, showing a very interesting collection of Westinghouse station apparatus, converters, meters, switches and a considerable variety of minor conveniences.

The Connecticut Motor Company, of Plantsville, Conn., exhibited two motors wound for street railway currents—½ h. p. and 1½ h. p., respectively—and public appreciation of them was promptly shown by the sale of one of the samples to a representative of an electric railroad.

Mr. H. F. Probert was on hand looking after the interests of the Three Rivers electrical motor truck, built by the Sheffield Velocipede Car Company, Three Rivers, Mich. A fine model operated by a Rae motor arrived Thursday and was on exhibition during the remainder of the afternoon.

Mr. R. B. Pierrepont represented Gould & Watson, of Boston, who showed some attractive novelties in molded mica insulators. Their new style clip for trolley line insulators, which does not require any soldering, attracted especial attention, and is now in use by the Thomson-Houston Company.

The Electric Merchandise Company, of Chicago, showed a large and interesting display of their specialties in one of the hotel parlors. They were represented by Mr. W. R. Mason and distributed a handsome and complete catalogue of all the apparatus that goes to make up the equipment of a street car line.

The McGuire Manufacturing Company, makers of the truck under the great Westinghouse Pullman car, which was on exhibition near the Cold Spring power station, was represented by Mr. McGuire and Messrs. Cook and Hubbard, and distributed a neat catalogue of their various types of trucks for electric cars.

F. S. Pease exhibited simply the various medals he has received for his lubricating and illuminating oils. These are from countries in all parts of the world. He is the only man that has taken a medal at a world's fair for this specialty, receiving the first medal from London in 1862 and the only gold medal given at the Paris Exhibition in 1878.

Pierce Brothers, of Boston, manufacturers of trolley wire fixtures, were represented by Mr. Pierce, who had a very pretty exhibit in Arcade Hall. A new automatic switch for overhead work attracted much attention among the practical railway men present, as it allowed of free passage of the car in either direction—not a common virtue in overhead switches.

The Buffalo Street Railway Company issued a very neat and attractive hand-book, with the programme of the convention, entertainments, views of Niagara Falls, etc., inclosed in were 20 street cars tickets, good during the days of the convention. This company did everything possible to entertain the visitors. It managers are entitled to the sincere thanks of the members.

J. G. Brill & Co., of Philadelphia, who were represented by Messrs. J. A. Brill, Hanna and Andrews, had some fine models of their standard brakes for motor cars, beside a full-sized electric truck, standing just outside the hotel and equipped with the Brill automatic equalizer. In Arcade Hall they displayed the end of a vestibuled electric car, with a special brake lever and other car appliances.

A unique device, of considerable interest to street railway men, was shown in Arcade Hall. This was the Morton safety car heater, which consists of a specially prepared porous cylindrical brick arranged to be fitted in pipes along the floor of the car and heated by steam passing through it, when the heat is retained for some hours and the car successfully heated without the need of a stove.

J. H. Bickford & Co., of Salem, Mass., distributed circulars containing illustrations and descriptions of the "Perfection" grease cup for electric street railway motors. This cup is made to fit either Edison, Thomson-Houston, Westinghouse, Short, or any other railway motor, and is the result of careful study and observation by Mr. Bickford, who is a thoroughly practical and experienced electric railway engineer.

Great credit is due to the *Street Railway Journal* for the prompt and effective manner in which it presented the proceedings of the convention to those present. A large delegation of its staff were present, headed by Mr. McGraw himself, and those in attendance are under great obligation for a large amount of valuable and convenient information which would otherwise be hard to gather. The *Street Railway Journal* has always been untiring in its efforts to further the interests of the Street Railway Association.

The Interior Conduit and Insulation Company showed a neat exhibit in one of the hotel parlors, including many samples of the Interior conduit and a particularly interesting specimen showing the underground construction of the same general character. This was examined with great interest, and was specially striking by reason of the simple and effective means taken to secure durability and good insulation. Mr. E. H. Johnson, president of the company, was present throughout the convention, together with other representatives.

The Peckham Street Car Wheel and Axle Company, of New York, represented by Mr. Peckham himself, had a beautiful display of models of the various forms of Peckham truck at the headquarters, while in front of the hotel were the trucks themselves, which displayed their good qualities even more effectively than the models. Mr. Peckham was loaded with the literature of the truck, and scattered broadcast around the corridors a unique humorous advertisement of the cantilever trucks that created great amusement among the delegates.

Mr. Cavell and Mr. Munroe, of the *Street Railway Gazette*, were on hand throughout the convention, and were active in looking out for the interests of the visiting delegates. They distributed a particularly elegant souvenir of the occasion, containing more than a score of beautifully executed portraits of leading members of the American Street Railway Association. It was a souvenir which will certainly be appreciated by street railway men, and commends itself by the elegance of its typographical work and the unusually meritorious portraits.

The Electrical Accumulator Company, represented by Mr. W. W. Griscom, Mr. D. H. Bates, and others of those interested, showed an Edco car in operation on the Cold Spring line. Its practical working left little to be desired, and the railway delegates, especially those from cities, grew quite enthusiastic over its excellent properties. It was running steadily during Wednesday and Thursday and carried large crowds on short trips up and down the lines. It was a handsomely finished car, equipped with a double motor truck operated by 88 cells of the Electrical Accumulator Company's battery.

The Aluminum Brass and Bronze Company, represented by Mr. F. G. Stone, general agent, distributed a neat catalogue of their various products, and also showed a line of samples that received more than ordinary attention. A number of the new aluminum trolley wheels were exhibited both at the hotel and in practical operation on three or four cars which were operated near the Cold Spring power house. Street railway men were peculiarly curious concerning the new material and were much pleased with its admirable performance under the test of actual service. The questions asked concerning its exceedingly small weight were innumerable and the samples on exhibition at the hotel were a cause of continual wonder.

A remarkably interesting and complete exhibit was that of Chadbourne, Hazelton & Co., who showed a beautiful set of models of their Wenstrom street car system and their well known wooden gearing. The Wenstrom motor, with its remarkably slow speed and exceedingly compact form, elicited very favorable opinions from the railway men who saw it. A small working model of an elevator gave opportunity of exhibiting the very ingenious hydraulic gear which promises to become an important part of the Wenstrom street railway system, inasmuch as it affords a power of regulating speed and putting on load easily that can hardly be surpassed by any other mechanical contrivance. It was viewed with great curiosity on account of its striking novelty and remarkable mechanical properties. The parlor which served as the headquarters for Chadbourne & Hazelton was crowded most of the time, and Mr. Chadbourne and Mr. Hazelton, together with Mr. Parshall and officers of the Westrom Company, did the honors of the exhibit, and, like their neighbors in the next parlor, were assiduous in looking out for the bodily and spiritual welfare of their visitors. They distributed some very handsome catalogues descriptive of the system.

The Thomson-Houston Company came early and often in the persons of Messrs. Cargill, Cahoon, Coffin, Mansfield, McCarthy, Clark, Ferguson, Knight, Morse and Jones. Their reception room was amply provided with evidence of their enterprise and activity, and all through the convention was the centre of attraction to numerous visiting friends. The most interesting portion of its practical exhibit, however, was near the Cold Spring power house on the electric railway, where two big track machines, a snow plow and a sweeper attracted an unusual crowd of street railway men. Wednesday afternoon they were ready for business, and their working qualities were shown to a large crowd. In default of snow, the plow had to be contented with comparative idleness, but the sweeper was on the war path. Both these machines were fitted with aluminum trolley wheels that excited a great deal of curiosity on the part of the electric railway men present. The novel material behaved admirably, and its good qualities were the subject of much comment. The track cleaning machines are ready for the opening of the winter season, and the railway managers who have suffered inconvenience from the inevitable snow inspected them very carefully. The Thomson-Houston representatives were active throughout the convention, and many were the delegates who inspected what they had to show and found a resting place in their hospitable headquarters.

The Short Electric Railway Company was present at the convention in force with a very beautiful exhibit, which was displayed in the hotel parlor. Prof. S. H. Short headed the delegation, and four or five assistants looked after the interests of the company in every possible way. On a table in the centre of the parlor was placed a standard Short street railway motor in operation, running very quietly at a low rate of speed. Upon it was an elaborate fixture blazing with incandescent lamps, while around the room were arranged photographs and woodcuts of interesting parts of the system and plants which had been installed. A corner was occupied with an excellent exhibit of the accessories of the system-switches, cut-outs, lightning arrester, rheostat, reversing gear and various minor articles. The display was very artistically arranged, and reflects great credit on the management of the company. At this particular time the first cars of the Rochester Railway were ready for operation, which added interest to the technical display of the company, and many of the street railway men were on hand to talk over its good points. Aside from the indoor exhibit, a particularly beautiful private car was placed directly in front of the hotel and was surrounded by admiring throngs most of the time. It was most elaborately and beautifully upholstered and finished, being, in fact, a miniature parlor car as luxurious in its way as the finest railway car in service to-day.

At last the Westinghouse Company took the warpath in force, and the braves who upheld its totem were H. McL. Harding, J. S. Barclay, Messrs. Osgood, Denniston and Buthford. The headquarters was amply provided with Westinghouse literature, blue prints, and the like, but there was small need for these minor accessories when the motor itself was present and in operation on a beautiful Pullman car, vestibuled and decorated in the most elaborate and artistic fashion. This car was an eight-wheeler driven by two 15 h. p. Westinghouse motors mounted on Hubbard trucks. During Wednesday and Thursday this car was in steady operation and was visited by throngs. Hardly any street railway men present in Buffalo missed the opportunity to inspect the new motor. Long and heavy as it was—for it measured 34 feet over all—the car ran very smoothly and quietly, and was kept under perfect control by the very neat air-brake system, which was operated by a special pump worked by a sprocket chain from one of the axles. This car probably attracted more attention than any other single exhibit during the convention. So much had been heard of the qualities of the Westinghouse motor, and so little was known by the average street car man, that he hastened to make himself acquainted with its working details, and the exhibition of its powers must have been most satisfactory to the Westinghouse Company. The ease of getting at the working parts of the motor for repairs was a feature which particularly struck electric railway men present and called forth a great deal of commendation.

Very prominent from its completeness and elegance was the Edison exhibit. The representatives of the company turned out in full force. Mr. E. E. Higgins, special agent of the railway department, had charge of the elaborate display, and with him Mr. Muir and Messrs. Greene, Vail, Shain, Van Sise, Hewitt, Chinnock, Page, Ball and others. The hotel headquarters was made into a very attractive reception room, where some new object of interest was continually turning up. Models of street cars equipped with the latest form of motor trucks gave added emphasis to a huge wall map that filled one end of the great parlor, dotted all over with markers showing the location of all the street railways operated on this system, and the whole artistically draped and illuminated by a stand of incandescent lamps. On the opposite wall was a capital portrait of Mr. Edison, flanked by two maps showing the details of the great St. Paul-Minneapolis united street railways. These were re-enforced by a large number of other maps and blue prints furnishing further details of electric railway work. Of great interest was the phonograph display. Several instruments were in position, and one of them seemed specially adept at reproducing music. A large and remarkably good collection of musical phonograms was at hand, and their performance gave delight to scores of visitors during the convention. A well-stored buffet showed that the genial managers were not neglectful of the less intellectual needs of their many friends. At the Arcade building was another and more technical display of Edison machinery. A beautifully arranged switchboard afforded an excellent opportunity for the exhibition of station apparatus, measuring instruments, safety devices and switches. Close alongside might be seen the Eickemeyer armature recently adopted by the Edison Company and, what was even more interesting and instructive, a wooden core, half wound with the Eickemeyer coils to show just the manner of their application. A full sized double motor truck, equipped with the regular motors, gave an opportunity to show the modifications of the Sprague truck made at the hands of the new management. All the appurtenances were laid open in full view, so that the passing street railway man could not fail to be attracted. A pair of tiny dynamos illustrated the familiar type of Edison generator, and, in fact, nothing that could show the application of Edison apparatus to the generation and transmission of power was absent. The representatives of the company were untiring in their efforts to give information and kindly attention to their visiting friends. One happy thought should be remembered: Thursday morning each delegate received a mysterious looking pasteboard cylinder tied up with red ribbon. On investigation, this proved to contain a wax cylinder bearing in phonographic characters a pleasant greeting from the Edison Company, translatable into a language understanded of the people on presentation to the magical little instrument at the Edison headquarters. It would be hard to find a more complete and well managed exhibition of electrical appliances than the Edison General Company elaborated at this convention, and that it was thoroughly appreciated was evidenced by the throng of visitors that crowded headquarters and exhibit all day long and as nearly all night as even the owlish proclivities of the most wide-awake delegates would warrant.

THE ATTENDANCE.

The following is a list of delegates and members of the association who were present:

Atlanta, Ga.—W. S. Larendon, superintendent, Atlanta Street Railway Company.

Baltimore, Md.—Wm. A. House, Jr., general manager, Baltimore Traction Company.

Birmingham, Conn.—H. Holten Wood, president, Derby Horse Railway Company.

Boston, Mass.—Edmond Reardon, vice-president: F. H. Monks, general manager; Louis Pfingst, master mechanic; West End Railway Company. A. F. Breed, president; E. C. Foster, superintendent; Lynn & Boston Railroad Company.

Bridgeport, Conn.—B. F. Lasher, superintendent, Bridgeport Horse Railway Company.

Brockton, Mass.—Wm. M. Cross, president; H. B. Rogers, general manager; Brockton Street Railway Company.

Brooklyn, N. Y.—Wm. Richardson, president; W. J. Richardson, secretary; Atlantic Avenue Railway Company. D. F. Lewis, president; E. W. Bliss, director: Brooklyn City Railway Company. D. F. Lewis, president; E. W. Bliss, director; New Williamsburgh & Flatbush Railway Company.

Buffalo, N. Y.—S. S. Spaulding, president; H. M. Watson, treasurer; Buffalo East Side Street Railway Company. H. M. Watson, president; S. S. Spaulding, secretary; Buffalo Street Railway Company.

Camden, N. J.—Wm. S. Scull, president; Morris W. Hall, secretary; G. G. Brown, treasurer; Camden Horse Railway Company.

Canton, O.—F. A. Seiberling, treasurer; W. D. Chapman, engineer; Canton Street Railway Company.

Chicago, Ill.—H. H. Windsor, secretary; T. C. Pennington, treasurer; Chicago City Railway Co.

Cincinnati, O.—H. M. Littell, president; J. A. Collins, secretary; John Harris, superintendent, Cincinnati Street Railway Company. Jos. Thomas, director, and M. Adams, Inclined Plane Railway Company. H. M. Littell, president, Cincinnati Inclined Plane Railway Company, and Henry Martin, president, Mt. Auburn Cable Railway Company.

Cleveland, O.—J. J. Stanley and Horace Andrews, of the Broadway & Newburg Railroad Company. Chas. W. Wason, electrical engineer, and H. A. Everett, secretary, East Cleveland Railroad Company.

Covington, Ky.—G. M. Abbott, treasurer; Geo. Bullock; S. Covington & Cincinnati Street Railway Co.

Davenport, Ia.—Wm. L. Allen, president, Davenport Central Railway Company.

Detroit, Mich.—James H. Vhay. president; H. W. Goodwin, secretary; Fort Wayne & Elmwood Railway Company.

Dover, N. H.—H. W. Burgett, vice president, Union Street Railway Company.

Easton, Pa.—H. A. Sage, president, Easton, South Easton & West End Railway Company.

Fall River, Mass.—Robert E. Goff, secretary, Globe Street Railroad Company.

Findlay, Ohio.—Charles Smith, superintendent, Findlay Street Railway Company.

Hamilton, Ont.—B. E. Carlton, president; T. B. Griffith, secretary and treasurer; J. B. Griffith; Hamilton Street Railway Company.

Harrisburg, Pa.—H. A. Kelker, president; A. Roberts, secretary; Harrisburg City Passenger Railway Company.

Hartford, Conn.—E. S. Goodrich, president, Hartford & Wethersfield Railway Company.

Indianapolis, Ind.—J. C. Shaffer, president, Citizens' Street Railway Company.

Kansas City, Mo.—R. J. McCarty, general manager, Metropolitan Street Railway Company.

Lafayette, Ind.—G. E. C. Johnson, president, Lafayette Street Railway Company.

Lincoln, Neb.—E. L. Woolley, superintendent, Lincoln Street Railway Company.

Little Rock, Ark.—H. B. Bradford, secretary; J. M. Gaylor director; Little Rock & Citizens' Street Railway Company.

London, Can.—V. Cronyn, president; T. H. Smallman, director; London Street Railway Company.

Louisville, Ky.—H. H. Littell, general manager, Louisville Railway Company.

Lowell, Mass.—E. M. Tucker, president; E. J. Noyes, superintendent, and Frank M. Howe, director; Lowell Horse Railroad Company.

Manchester, N. H.—C. Williams, president; N. H. Walker, superintendent; Manchester Street Railway Company.

Memphis, Tenn.—R. Semmes, of the Citizens' Street Railway Company.

Minneapolis, Minn.—Thomas Lowry, president, Minneapolis Street Railway Company.

Newark, N. J.—Thomas E. Barr, president, Newark Passenger Railway Company.

Nashua, N. H.—George H. Knowles, president, and Chas. Williams, director; Nashua Street Railway Company.

Newburyport, Mass.—C. Odell, president; J. K. Kerr, substitute; T. H. Johnson and R. R. Brown, directors; Newburyport & Amesbury Horse Railroad Company.

New York City, N. Y.—Wm. Richardson, director, Dry Dock, East Broadway & Battery Railway Company. G. Green, president; J. M. Calhoun, superintendent; 42d Street & Grand Street Ferry Railway Company. W. H. Delaney, president; R. Avery, director; North & East River Railroad Company. T. H. McLean, secretary, 23d Street Railway Company. D. B. Hasbrouck, vice-president; Houston, West Street and Pavonia Ferry Railroad Company. C. Densmore Wyman, vice-president, and J. N. Valentine, secretary; Central Park, North & East River Railroad Company.

Niagara Falls, N. Y.—C. B. Gaskill, president; C. B. Hill, secretary; G. B. Johnson, superintendent; B. H. Johnson, A. Mevot and A. J. Porter, directors; Niagara Falls & Suspension Bridge Railway Company.

Omaha, Neb.—W. A. Smith, general manager, Omaha Street Railway Company.

Orange, N. J.—F. M. Eppely, president, Orange Crosstown & Bloomfield Street Railway Company.

Ottawa, Can.—T. C. Keefer, president; Ottawa City Passenger Railway Company.

Peoria, Ill.—H. R. Woodward, vice-president and general manager of the Central Railway Company.

Philadelphia, Pa.—E. B. Murphy, president, Lombard & South Street Passenger Railway Company. E. B. Murphy, president, Peoples' Passenger Railway Company.

Pittsburgh, Pa.—J. B. Holmes, president; J. E. Briggs, superintendent; Citizens' Traction Company. D. F. Henry, president; W. M. Ramsey, electric superintendent, Federal Street & Pleasant Valley Passenger Railway Company.

Providence, R. I.—M. H. Bronsdon, superintendent, Providence Cable Tramway Company. A. T. Potter, general manager; H. V. A. Joslin, secretary; Union Railroad Company.

Reading, Pa.—B. F. Owen, president, Reading City Passenger Railway Company.

Rochester, N. Y.—A. G. Yates, president; J. N. Beckley, vice-president; A. Luetchford, treasurer; M. A. Verner, general manager; S. McKee and Fred. Cook, directors; Rochester Railway Company.

Salt Lake City, Utah.—Walter P. Reed, superintendent, Salt Lake City Railroad Company.

Savannah, Ga.—Henry Parsons, engineer, and George Parsons, director, City and Suburban Railway Company.

Sioux City, Ia.—C. W. Hornick, president, Riverside Park Railway Company.

Sandusky, O.—C. Rude, superintendent, Sandusky Street Railway Company.

Sioux City, Ia.—J. F. Peavey, president, Sioux City Street Railway Company.

Springfield, Mass.—A. E. Smith, treasurer, Springfield Street Railway Company.

St. Louis, Mo.—Chas. Green, president People's Railway Company. R. McCulloch, general manager, St. Louis Railway Company.

St. Paul, Minn.—Thomas Lowry, president, St. Paul City Railway Company.

Toledo, O.—A. E. Lang, president; D. E. Bailey; Toledo Consolidated Street Railway Company.

Topeka, Kan.—C. S. Gleed, president; E. H. Littlefield, superintendent: Topeka City Railway Company.

Toronto, Can.—J. Gunn, secretary; G. W. Kiely, managing director; G. F. Shipley, solicitor; Toronto Street Railway Company.

Trenton, N. J.—C. Y. Bamford, treasurer; A. L. Worthington, director; City Railway Company. L. Perrine, Jr., president; W. S. Gulick, assistant superintendent; Trenton Horse Railroad Company.

Troy, N. Y.—Chas. Cleminshaw, president and Chas. H. Smith, superintendent of the Troy & Lansingburg Railroad Company.

Taunton, Mass.—George C. Morse, superintendent, Taunton Street Railway Company.

Terre Haute, Ind.—R. W. Rippetoe, president, Terre Haute Street Railway Company.

Washington, D. C.—Wm. Dunlap and C. C. Sailor, superintendent of the Washington & Georgetown Railroad Company; George W. Pearson, president, and Robert Beale, director of the Metropolitan Railroad Company, and J. Stephenson, president, and R. F. Baker, secretary and treasurer of the Columbia Railroad Company.

West Haven, Conn.—I. A. Kelsey, president; S. A. Stevens, secretary; New Haven & West Avenue Horse Railway Company.

Wilmington, Del.—E. W. Heald, general manager, Wilmington City Railway Company.

Worcester, Mass.—C. B. Pratt, president; H. S. Seeley, secretary; Worcester Consolidated Railway Company.

York, Pa.—W. H. Lanius, president; D. K. Trimmer, secretary; F. Guise, treasurer; D. A. Rupp, stockholder; York Street Railway Company.

Of the roads which were not members of the association the following were represented by the gentleman named:

Alton, Ill.—Alton Improvement Association, H. R. Kinney, secretary.

Asheville, N. C.—Asheville Street Railway Company, B. M. Jones, secretary and treasurer.

Boston, Mass.—Boston and Revere Electric Railway Company, W. G. Benedict, president; N. M. Jewett, director.

Decatur, Ill.—Citizens' Electric Street Railway Company, Wm. L. Forguson, superintendent.

Erie, Pa.—Erie Passenger Railway Company. J. F. Pfetch, general manager.

Fort Scott, Kan.—Fort Scott Rapid Transit Railway Company, A. L. Hughes, treasurer.

Forth Worth, Tex.—North Side Railway Company, George B. Hendricks, secretary.

Joliet, Ill.—Joliet Street Railway Company, John Hulsizer, secretary.

Lawrence, Mass.—Merrimac Valley Railway Company, W. B. Ferguson, president; John Munningham, director.

Oswego, N. Y.—Oswego Street Railway Company, Francis J. Callanan, president.

Piqua, O.—Piqua Street Railway Company, F. C. Davies, secretary.

Plymouth, Mass.—Plymouth & Kingston Street Railway Company, C. E. Barnes, superintendent.

Pottsville, Pa.—People's Railway Company, Wm. D. Baber.

Richmond, Ind.—Richmond City Street Railway Company, Wm H. Shaffer, general manager.

Salem, Oregon.—Capital City Railway Company, P. S. Knight, president.

St. Joseph, Mo.—Wyatt Park Railway Company, W. J. Hobson, president.

Wheeling, W. Va.—Citizens' Railway Company, J. A. Miller, president; M. Loftus, superintendent; John M. Sweeney, director. Wheeling Railway Company, John M. Sweeney, president; M. Loftus, superintendent.

The St. Louis Exposition.

The exposition closed last week, and the exhibitors in what is termed the electrical department are returning home. Among the exhibitors that arrived after the opening were the Municipal Signal Company, of Boston, showing a complete outfit of its police and fire alarm system and apparatus, under the charge of Mr. E. I. Skinner, and which attracted much attention. The Hazletine Electric Company, St. Louis, exhibited an arc lamp fitted with one of its protective shields, which is said to increase the life of the carbon fully 50 per cent., and not to affect the light in any manner, and which can be fitted to any lamp without any change in its mechanism. The representatives of the Waite & Bartlett Manufacturing Company, of New York, exhibited one of their improved Holtz induction machines till the prevailing dampness compelled them to remove it. They also displayed various forms of physicians' cabinets for electrical treatment, and had a large display of the A. X. O., "Gonda" and "Gonda porous" cup battery, made by the Leclanché Battery Company, of New York. The Connecticut Motor Company, of Plantsville, Conn., made a nice exhibit of its motors and has given the agency to the Southern Electrical Supply Company, of St. Louis.

The Universal Arc Lamp Company, of New York, had its general manager, E. S. Mendels, on the ground with a sample arc lamp that attracted much attention when placed on the incandescent circuits. Mr. Boyd E. Anderson, of Texarkana, Ark., exhibited the Anderson form of storage battery, for which the St. Louis Electrical Supply Company will hereafter act as agents. The Page Belting Company, of Concord, N. H., displayed some handsome specimens of the Acme link belt, and had a number running on various dynamos, and its entire exhibit was made a centre of attraction by its representative, Mr. J. E. Lambie. The Johnston Electric Train Signal Company, of Boston, added a number of specialties in the way of push buttons, bells, batteries, etc., and its active agent, Mr. Merrill, of Chicago, has secured many orders for house goods while stopping in the city. This company is also showing the American electric register for street car use.

The Columbia Incandescent Lamp Company, of St Louis, has filled the electrical section with its lamps, and many compliments have been paid on account of brilliancy and efficiency.

The Union Electrical Construction Company, of St. Louis, has one of the handsomest exhibits in the building, and one that has attracted the attention of every prominent citizen, as it is made up wholly of house goods, annunciators, pushes, electroliers, combination fixtures, etc., with a rich line of glassware, all set off by a variety of colored incandescent lamps supplied with current from a Western Electric incandescent dynamo. The Sperry Electric Company, of Chicago, have one of their thirty-light dynamos supplying current to a number of the improved Sperry arc lamps as well as to the exhibit of other companies, and much attention has been attracted by the smooth running of the machine and the excellent illumination afforded. Mr. J. B. Riley, of the home office, is the representative in charge, and won many friends by his close attention to the interests of his company and his geniality. The Shultz Belting Company, of St. Louis, added to its exhibit the big 24-inch patent woven leather belts sold to the Lindell Street Railway Company. The Great Western Electrical Supply Company, of Chicago, had an exhibit of electric fittings, street car supplies, telegraph and testing instruments, etc., in charge of Mr. George T. Hewes. The National Electric Company, of Eau Claire, made several additions to its exhibit, which was one of the marked features of the section. Westinghouse, Church, Kerr & Co., had one of each of their well-known engines in position, including the "Automatic," the "Junior" and the "Compound," and also exhibited a model of their "steam loop." Mr. E. P. Southworth was in charge.

The Thomson-Houston Electric Company's exhibit fully met the anticipations of the management, and was probably admired more than any one other exhibit, and Mr. B. J. Arnold, of St. Louis, can well flatter himself that his work was well done. As previously mentioned, the company exhibited arc and incandescent dynamos driven by an Armington & Sims engine, within a booth, elegantly furnished, and having a miniature electric railway track suspended near the ceiling of the booth, around which ran a small locomotive and train of cars lighted and propelled by electricity. The electric cascade apparently became the property of the C., B. & Q. Railway Company, as it was used solely in advertising its interests. Many of the exhibitors expressed their dissatisfaction on account of the display being placed in the basement, where the noise and vibration and dampness causes more or less annoyance; but various changes are outlined for the coming year that may awaken renewed interest. Too much praise cannot be given to the companies who did expend time and money in an effort to make the exhibit a success.

Water Power and Electric Transmission.*

The first practical demonstration of electric transmission of power for mining purposes in California has been inaugurated by the American River syndicate in El Dorado County—an English organization under the management of Mr. George Cullen Pearson. The power station is located on Rock Creek, some 1,500 feet below the mine and mill and two miles distant in a straight line.

The plant consists of an 8-foot Pelton wheel, which, running under a head of 110 feet at 100 revolutions with 5½-inch nozzle, has a maximum capacity of 130 h. p. To this wheel is connected a 100 h. p. Brush generator, speeded at 900 revolutions, the current from which is carried to the mill through a single insulated copper wire, No. 3 B. & S. gauge, the return being made by a wire of the same size, making a four-mile circuit. The power from the generator is communicated to the countershaft of the mill by a 70 h. p. Brush motor running at 950 revolutions.

The machinery operated consists of three centrifugal roller mills, a ten-stamp battery and a rock breaker. The Pelton wheel under these conditions shows an efficiency of 86 per cent., while 85 per cent. of the power thus generated is available for duty at the mill, though only 70 per cent. was called for in the contract with the Brush Company. Sufficient power is taken from the main circuit to run 60 incandescent lamps for lighting the works, the current being cut in by means of the Brush multiple series cut-out box, which admits of incandescent lights being operated by a high-tension current.

The company owning their own water right, the operating expenses of this plant are almost nominal; only one attendant is required at the power station, and this not an electrical expert, but one of the company's employés. If the distance between the generating station and the mill were five or ten miles instead of two, it would simply have been a question of a larger expenditure for wire with a somewhat smaller percentage of power delivered.

This equipment has been in constant operation for five months and is a most pronounced success, no interruption to the service of any moment having occurred during this time. The mills named are handling an average of 4,000 tons of ore per month, effecting a saving of some 60 per cent. over the former method of working by steam power, estimating wood at $3.50 per cord, while the cost of maintenance is about as six to one in favor of electricity.

* From the San Francisco *Mining Review*.

The Electromagnet.*

BY PROF. SILVANUS P. THOMPSON, D. SC., B. A., M. I. E. E.

We are now in a position to understand the bearing of some curious and important researches made about 40 years ago by Dr. Julius Dub, which, like a great many other good things, lie buried in the back volumes of Poggendorff's "Annalen." Some account of them is also given in Dr. Dub's now obsolete book, entitled "Elektromagnetismus."

The first of Dub's experiments to which I will refer relates to the difference in behavior between electromagnets with flat and those with pointed pole ends. He formed two cylindrical cores, each six inches long, from the same rod of soft iron, one inch in diameter. Either of these

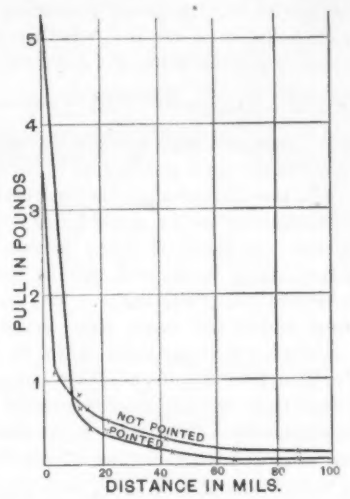


FIG. 35.--CONTRASTED EFFECT OF FLAT AND POINTED POLES.

could be slipped into an appropriate magnetizing coil. One of them had the end left flat, the other had its end pointed, or, rather, it was coned down until the flat end was left only half an inch in diameter, possessing therefore only one-quarter of the amount of contact surface which the other core possessed. As an armature there was used another piece of the same soft iron rod, twelve inches long. The pull of the electromagnet on the armature at different distances was carefully measured, with the following results:

Distance apart in inches.	Pull on Flat Pole (lbs.).	Pull on Pointed Pole (lbs.).
0.	3.3	5.2
0.0055	1.1	1.8
0.0110	0.9	0.75
0.0165	0.71	0.50
0.022	0.60	0.42
0.044	0.38	0.20
0.088	0.19	0.09

These results are plotted out in the curves in Fig. 35. It will be seen that in contact, and at very short distances, the reduced pole gave the greater pull. At about ten mils distance there was equality, but at all distances greater than ten mils the flat pole had the advantage. At small distances the concentration of magnetic lines gave, in accordance with the law of traction, the advantage to the reduced pole. But this advantage was, at the

FIG. 37.—DUB'S DEFLECTION EXPERIMENT.

greater distances, more than outweighed by the fact that with the greater widths of air-gap the use of the pole with larger face reduced the magnetic reluctance of the gap and promoted a larger flow of magnetic lines into the end of the armature.

Dub's next experiments relate to the employment of polar extensions or pole-pieces attached to the core. These experiment are so curious, so unexpected, unless you know the reasons why, that I invite your especial attention to them. If an engineer had to make a firm joint between two pieces of metal, and he feared that a mere attachment of one to the other was not adequately strong, his first and most natural impulse is to enlarge the parts that come together—to give one, as it were, a broader footing against the other. And that is precisely what an engineer, if uninstructed in the true principles of magnetism, would do in order to make an electromagnet stick more tightly on to its armature. He would enlarge the ends of one or both. He would add pole-pieces to give the armature a better foothold. Nothing, as you will see, could be more disastrous. Dub employed in these experiments a straight electro-

*Cantor Lectures No. 2, continued from THE ELECTRICAL WORLD, Oct. 18, 1890.

magnet having a cylindrical soft iron core, 1 inch in diameter, 12 inches long; and as armature a piece of the same iron, 6 inches long. Both were flat-ended. Then six pieces of soft iron were prepared of various sizes, to serve as pole-pieces. They could be screwed on at will either to the end of the magnet core or to that of the armature. To distinguish them we will call them by the letters A, B, C, etc. Their dimensions were as follows, the inches being probably Bavarian inches:

Piece.	Diameter.	Length.
	Inches.	Inches.
A	2	1
B	1⅝	1¼
C	1⅜	2
D	2	⅛
E	1½	1
F	1	2

Of the results obtained with these pieces we will select eight. They are those illustrated by the eight collected sketches in Fig. 36. The pull required to detach was measured, also the attraction exerted at a certain distance apart.

Experiment.	On Magnet.	On Armature.	Traction.	Attraction
I.	None.	None.	48	22
II.	D	None.	30	10
III.	E	None.	32	11.5
IV.	C	None.	35	13.5
V.	D	A	20	7.5
VI.	None.	B	50	25
VII.	None.	D	43	25
VIII.	None.	C	50	18

It will be noted that, in every case, putting on a pole-piece to the end of the magnet diminished both the pull in contact and the attraction at a distance; it simply promoted leakage and dissipation of the magnetic lines. The worst case of all was that in which there were pole-pieces both

FIG. 36.—DUB'S EXPERIMENTS WITH POLE-PIECES.

on the magnet and on the armature. In the last three cases the pull was increased, but here the enlarged piece was attached to the armature, so that it helped those magnetic lines which came up into it to flow back laterally to the bottom end of the electromagnet, while thus reducing the magnetic reluctance of the return path through the air, and so, increasing the total number of magnetic lines, did not spread unduly those that issued up from the end of the core.

The next of Dub's results relate to the effect of adding these pole-pieces to an electromagnet 12 inches long, which was being employed, broadside on, to deflect a distant compass needle (Fig. 37).

Pole-piece used.	Deflection (degrees).
None	34.5
A	42
B	41.5
C	40.5
D	41
E	39
F	38

In another set of experiments of the same order a permanent magnet of steel, having poles *N S*, was slung horizontally by a bifilar suspension, to give it a strong tendency to set in a particular direction. At a short distance laterally was fixed the same bar electromagnet, and the same pole-pieces were again employed. The results of attaching the pole-pieces at the near end are not very conclusive; they slightly increased the deflection. But in the absence of information as to the distance between the steel magnet and the electromagnet, it is difficult to assign proper values to all the causes at work. The results were:

Pole-piece used.	Deflection (degrees).
None	8.5
A	9.2
B	9.5
C	10
D	8.8

When, however, the pole-pieces were attached to the distant end of the electromagnet, where their effect would undoubtedly be to promote the leakage of magnetic lines into the air at the front end without much affecting the distribution of those lines in the space in front of the pole, the action was more marked.

Pole-piece used.	Deflection (degrees).
None	8.5
A	10.0
B	10.3
C	10.3
F	10.1

Still confining ourselves to straight electromagnets, I now invite your attention to some experiments made in 1862 by the late Count Du Moncel as to the effect of adding a polar expansion to the iron core. He used as his core small iron tube, the end of which he could close up with an iron plug, and around which he placed an iron ring which fitted closely on to the pole. He used a special lever arrangement to measure the attraction exercised upon an

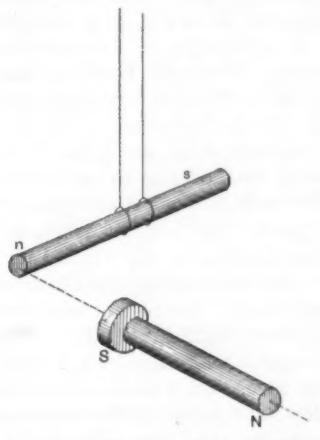


FIG. 38.—DEFLECTING A STEEL MAGNET HAVING BIFILAR SUSPENSION—POLE-PIECE ON NEAR END.

armature distant in all cases one millimetre from the pole. The results were as follows:

	Without ring on pole.	With ring on pole.
Tubular core alone	11	10
" " with iron plug	17	4
Core provided with mass of iron at distant end	27	3
" " " with iron plug	38	

Du Moncel also made experiments on horseshoe magnets, with results which will be noticed in due course.

After hunting up these researches it was extremely interesting to find that so important a fact had not escaped the observant eye of the original inventor of the electromagnet. In Sturgeon's "Experimental Researches" p 113) there is a foot note, written apparently about the year 1832, which runs as follows:

"An electromagnet of the above description, weighing three ounces, and furnished with one coil of wire, supported fourteen pounds. The poles were afterwards made to expose a large surface by welding to each end of the cylindrical bar a square piece of good soft iron; with this alteration only the lifting power was reduced to about five

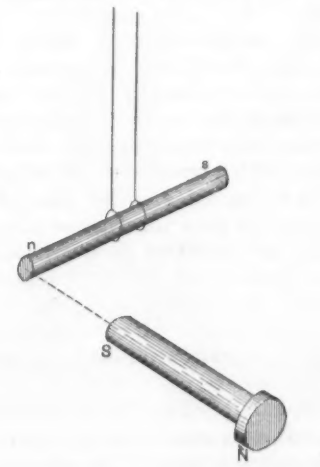


FIG. 39.—DEFLECTING STEEL MAGNET—POLE-PIECE ON DISTANT END.

pounds, although the magnet was annealed as much as possible."

Now let me invite your attention to another point. We saw that this straight electromagnet, whether used broadside on or end on, could act on the compass needle at some distance from it, and deflect it. In those experiments there was no return path for the magnetic lines that flowed through the iron core save that afforded by the surrounding air. The lines flowed round in wide-sweeping curves from one end to the other, as in Fig. 25; the magnetic field being quite extensive. Now, what will happen if we provide a return path? Suppose I surround the electromagnet with an iron tube of the same length as itself, the lines will flow along in one direction through the core, and will find an easy path back along the outside of the coil. Will the magnet thus jacketed pull more powerfully or less on that little suspended magnet? I should expect it to pull less powerfully, for if the magnetic lines have a good return path here through the iron tube, why should they force themselves in such a quantity to a distance through air in order to get home? No, they will naturally return short back from the end of the core into the tubular iron jacket. That is to say, the action at a dis-

tance ought to be diminished by putting on that iron tube outside. Here is the experiment set up. And you see that when I turn on the current my indicating needle is scarcely affected at all. The iron jacket causes that magnet to have much *less* action at a distance. Yet I have known people who actually proposed to use jacketted magnets of this sort in telegraph instruments, and in electric motors, on the ground that they give a bigger pull. You have seen that they produce less action at a distance across air, but there yet remains the question whether they give a bigger pull in contact? Yes, undoubtedly they do; because everything that is helping the magnetism to get round to the other end increases the goodness of the magnetic circuit, and therefore increases the total magnetic flux.

We will try this experiment upon another piece of apparatus, one that has been used for some years at the Finsbury Technical College. It consists of a straight electromagnet set upright in a base-board, over which is erected a light gallows of wood. Across the frame of the gallows goes a winch, on the axle of which is a small pulley with a cord knotted to it. To the lower end of the cord is hung a common spring balance, from the hook of which depends a small horizontal disc of iron to act as an armature. By means of the winch I lower this disc down to the top of the electromagnet. The current is turned on: the disc is attracted. On winding up the winch I increase the upper pull until the disc is detached. See, it required about nine pounds to pull it off. I now slip over the electromagnet, without in any way attaching it, this loose jacket of iron —a tube, the upper end of which stands flush with the upper polar surface. Once more I lower the disc, and this time it attaches itself at its middle to the central pole, and at its edges to the tube. What force will now be required to detach it? The tube weighs about one-half pound, and it is not fixed at the bottom. Will 9½ pounds suffice to lift the disc? By no means. My balance only measures up to 24 pounds, and even that pull will not suffice to detach the disc. I know of one case where the pull of the straight core was increased 16-fold by the mere addition of a good return path of iron to complete the magnetic circuit. It is curious how often the use of a tubular jacket to an electromagnet has been reinvented. It dates back to about 1850, and has been variously claimed for Romershausen, for Guillemin, and for Fabre. It is described in Davis' "Magnetism," published in Boston in 1848. About sixteen years ago Mr. Faulkner, of Manchester, revived it under the name of the *Altandae* electromagnet. A discussion upon electromagnets inclosed in iron jackets took place in 1876 at the Society of Telegraph Engineers; and in the same year similar electromagnets were used by Professor Graham Bell in the telephone receivers which he exhibited at the Centennial Exhibition at Philadelphia, the outer periphery of the jacket serving to hold down the edges of the vibrating iron diaphragm. But the jacket of iron is not really good for anything except increasing the tractive power. Of course, jacketing an electromagnet which already possesses a return circuit of iron is an absurdity. For this reason the proposal made by one inventor to put iron tubes outside the coils of a horseshoe electromagnet is one to be avoided.

We will take another paradox, which equally can be explained by the principle of the magnetic circuit. Suppose you take an iron tube as an interior core; suppose you cut a little piece off the end of it; a mere ring of the same size. Take that little piece and lay it down on the end. It will be struck with a certain amount of pull. It will pull off easily. Take the same round piece of iron, put it on edgewise, where it only touches one point of the circumference, and it will stick on a good deal tighter, because it is there in a position to increase the magnetic flow of the magnetic lines. By concentrating the flow of magnetic lines over a small surface of contact increases $\mathfrak{B}$ at that point, and $\mathfrak{B}^2$, integrated over the lesser area of the contact, gives a total bigger pull than is the case when the edge is touched all round against the edge of the tube.

Here is a still more curious experiment. I use a cylindrical electromagnet set up on end, the core of which has at the top a flat, circular polar surface—about two inches in diameter. I now take a round disc of thin iron—ferrotype or tin plate will answer quite well—which is a little smaller than the polar face. What will happen when this disc is laid down flat and centrally on the polar face? Of course you will say that it will stick tightly on. If it does so, the magnetic lines which come in through its under surface will pass through it and come out on its upper surface in large quantities. It is clear that they cannot all, or even any considerable proportion of them, emerge sideways through the edges of the thin disc, for there is not substance enough in the disc to carry so many magnetic lines. As a matter of fact the magnetic lines do come through the disc and emerge on its upper surface, making indeed a magnetic field over its upper surface that is nearly as intense as the magnetic field beneath its under surface. If the two magnetic fields were exactly of equal strength, the disc ought not to be attracted either way. Well, what is the fact? The fact, as you see now that the current has been turned on, is that the disc absolutely refuses to lie down on the top of the pole. If I hold it down with my finger, it actually bends itself up and requires force to keep it down. I lift my finger, and over it flies. It will go anywhere in its effort to better the magnetic circuit rather than lie flat on top of the pole.

Next I invite your attention to some experiments, orinally due to Von Kolke, published in the *Annalen* forty years ago, respecting the distribution of the magnetic lines where they emerge from the polar surface of an electromagnet. I cannot enumerate them all, but will merely illustrate them by a single example. Here is a straight electromagnet with a cylindrical, flat-ended core (Fig. 41). In what way will the magnetic lines be distributed over at the end? Fig. 41 illustrates roughly the way in which, when there is no return path of iron, the magnetic lines leak through the air. The main leakage is through the ends, though there is some at the sides also. Now the question of the end distribution we shall try by using a small

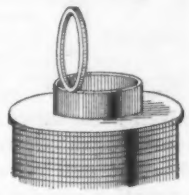


Fig. 40.—Experiment with Tubular Core and Iron Ring.

bullet of iron, which will be placed at different points from the middle to the edge, a spring balance being employed to measure the force required to detach it. The pull at the edge is much stronger than at the middle, at least four or five times as great. There is a regular increase of pull from the middle to the edge. The magnetic lines, in trying to complete their own circuit, flow most numerously in that direction where they can go furthest through iron on their journey. They leak out more strongly at all edges and corners of a polar surface. They do not flow out so strongly at the middle of the end surface, otherwise they would have to go through a larger air circuit to get back home. The iron is consequently more saturated round the edge than at the middle; therefore, with a very small mag-

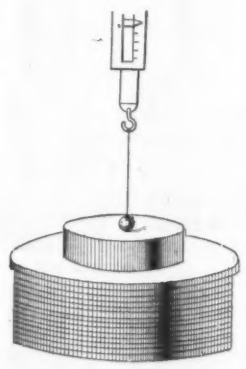


Fig. 41.—Exploring Polar Distribution with Small Iron Ball.

netizing force, there is a great disproportion between pull at the middle and that at the edges. With a very large magnetizing force you do not get the same disproportion, because if the edge is already far saturated you cannot by applying higher magnetizing power increase its magnetization much, but you can still force more lines through the middle. The consequence is, if you plot out the results of a succession of experiments of the pull at different points, the curves obtained are, with larger magnetizing forces, more nearly straight than are those obtained with small magnetizing forces. I have known cases where the pull at the edge was six or seven times as great as in the middle with a small magnetizing power, but with larger power not more than two or three times as

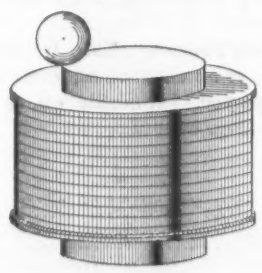


Fig. 42.—Iron Ball Attracted to Edge of Polar Face.

great, although, of course, the pull all over was greater. You can easily observe this distinction by merely putting a polished iron ball upon the end of the electromagnet, as in Fig. 42. The ball at once rolls to the edge and will not stay at the middle. If I take a larger two-pole electromagnet (like Fig. 11), what will the case now be? Clearly the shortest path of the magnetic lines through the air is the path just across from the edge of one polar surface to the edge of the other between the poles. The lines are most dense in the region where they arch over in as short an arch as possible, and they will be less dense along the longer paths, which arch more widely over. Therefore, as there is a greater tendency to leak from the inner edge of one pole to the inner edge of the other, and less tendency to leak from the outer edge of one to the outer edge of the other, the biggest pull ought to be on the inner edges of the pole. We will now try it. On putting the iron ball anywhere on the pole it immediately rolls until it stands perpendicularly over the inner edge.

The magnetic behavior of little iron balls is very curious. A small round piece of iron does not tend to move at all in the most powerful magnetic field if that magnetic field is uniform. All that a small ball of iron tends to do is to move from a place where the magnetic field is weak to a place where the magnetic field is strong. Upon that fact depends the construction of several important instruments, and also certain pieces of electromagnet mechanism.

(To be continued.)

On the Electrodynamics of Stationary Bodies.

BY H. HERTZ.

In accordance with the foregoing reasoning the quantity of "true" electricity on a surface, whether closed or unclosed, is obtained by integrating the expression

$$\frac{1}{4\pi}\int [X_p \cos(n,x) + Y_p \cos(n,y) + Z_p \cos(n,z)]\, d\omega$$

over the surface considered. We shall say that this expression is equal to the total number of lines of force cut by the surface in the direction of the normal drawn positively. This definition is in accordance with Faraday's suppositions that the lines of force point always in the direction of the acting force, and are in density proportional to the magnitude of the force. We shall complete the suppositions and at the same time make them more accurate by assuming that the lines of force in any body proceed in the direction not of the *force* but of the *polarization*, and that their density is proportional to the magnitude of the polarization. It follows from these definitions that 4π times the quantity of true electricity contained in any given volume is equal to the difference between the number of lines of force arriving at the bounding surface and those leaving it. Each end of a line of force represents a certain quantity of "true" electricity, and we can specify the quantity of this electricity by the number of free ends of the lines.

If some space situated in the neighborhood of the surface, over which the integral is calculated, is quite devoid of "true" electricity, the value of the integral is entirely independent of the particular shape and position of the surface throughout the space in question and depends simply on the contour of the surface. In such cases we shall say that the value of the integral is equal to the number of lines of force inclosed by the contour, without reference to the shape of the surface bounded by it.

The rate at which the quantity of "free" electricity e increases within a given space can be obtained from (13) and (16), and is given by the expression

$$\frac{de}{dt} = -\int \left(\frac{du}{dx} + \frac{dv}{dy} + \frac{d\omega}{dz}\right) d\tau$$

$$= -\int [u\cos(n,x) + v\cos(n,y) + \omega\cos(n,z)]\, d\omega \qquad (18)$$

by (15).

Now, if the region at the bounding surface is non-conducting, the conductivities λ are zero, and from (9) it follows that $u = v = \omega = 0$; so that from (18) we see that $\frac{de}{dt} = 0$, and that in consequence the quantity of "true" electricity within the space considered remains absolutely constant. Electricity cannot, therefore, escape from a body surrounded by a medium for which the quantities λ are zero. It is for this reason that we call such a medium non-conducting. If at any part of the bounding surface a body exists for which the quantities λ are not zero, variation of the electricity is possible; and hence such a body is called a good conductor in contrast with bad conductors within which electrical movement is only possible under the influence of electro-dynamic phenomena. The division of bodies into good and bad conductors only then refers to "true" electricity; with respect to "free" electricity, all bodies can be considered conducting, since polarization currents are transmitted by them.

The quantity of a substance within a given volume can only vary by the entrance or exit of a certain quantity of it through the bounding surface of the space considered; and each element of the bounding surface must pass a quantity, whose amount is perfectly determinate. In accordance with this axiom we may assume that the quantity of electricity per second (the electric current) crossing unit surface of each element is equal to

$$u\cos(n,x) + v\cos(n,y) + w\cos(n,z) \qquad (19)$$

and the integral of this taken over any surface is equal to the current flowing across this surface. We must remark that, even admitting the material nature of electricity, the special way in which we have obtained the electric current constitutes a great assumption. We can, in fact, to the system of currents found, superpose any closed system of currents without varying in the slightest degree the rate of increase or decrease at a given point.

If a part of the system can pass from the electrified to the non-electrified state, and *vice versa*, under the sole influence of electromagnetic phenomena, the amount of true electricity in each of the non-conductors is zero, and in consequence the quantities represented by the expressions (16 and 17) are each equal to zero for such bodies.

The same considerations that we have put forward for electrical phenomena can equally well be applied to magnetic phenomena. In fact, in the foregoing expressions we have merely to replace X, Y and Z respectively by L, M

* Continued from The Electrical World, Oct. 18, 1890.

and N. Thus the "true" magnetic volume and surface densities are given by the expressions

$$\frac{1}{4\pi}\left(\frac{d\,L_p}{d\,x}+\frac{d\,M_p}{d\,y}+\frac{d\,N_p}{d\,z}\right) \qquad (20)$$

and,
$$\frac{1}{4\pi}\{(L_{p,2}-L_{p,1})\cos(n,x)+(M_{p,2}-M_{p,1})\cos(n,y)+(N_{p,2}-N_{p,1})\cos(n,z)\} \qquad (21)$$

FIG. 31.—ARMATURE OF WESTINGHOUSE ALTERNATOR.

Again, the number of magnetic lines of force traversing a surface is given by the surface integral

$$\int\{L_p\cos(n,x)+M_p\cos(n,y)+N_p\cos(n,z)\}d\omega \qquad (22)$$

and by leaving out the suffixes p we get expressions which refer to "free" magnetism.

The distinction of bodies into good and bad conductors does not, however, occur for "true" magnetism, since equations (10) do not contain any conduction terms to correspond with equations (11). With regard to "free" magnetism, all bodies can be considered conducting as in the analogous electrical case. If a system, or a part of a system, can pass from its magnetic to its non-magnetic state, and *vice versa*, by purely electromagnetic means, the expressions (20) and (21) for volume and surface density can each be equated to zero.

(To be continued.)

Electrical Distribution by Transformers from Central and Eccentric Stations.*

BY DR. J. A. FLEMING, M. A.

§ 12. *Westinghouse Transformer System.*—In the last four years, beginning in 1886, the Westinghouse Electric Lighting Company has developed in the United States an immense industry in the manufacture and erection of alternating current plant for distribution of electric energy by transformer systems. At the present date (1890) there have been established by this corporation in America about 300 central stations, comprising a total of over 500,000 16 c. p. incandescent lamps operated by alternate current transformers. The several portions of this system have been designed with great care, and the mechanical and electrical construction of all parts has been brought to a high level of perfection. The standard type of alternator is represented in Fig. 30. In this alternator the revolving portion constitutes the armature and the stationary magnets the field. The field magnet is composed of a series of radial magnetic poles projecting inwards from the interior of a ring-shaped frame. These magnets are arranged to have alternate polarity at the inner ends. The magnet cores are formed of solid or laminated wrought iron, bolted to the inner circumference of a cast-iron cylindrical frame. On these cores are slipped exciting coils wound on shells, which are held in position by bolts at the extremities. These field-magnet poles are excited by the current from a small continuous current dynamo. The armature revolves in the cylinder space in the centre of these radial magnetic poles. The armature core consists of a drum-shaped mass of laminated soft iron, built up of sheet-iron discs, compressed and secured to the steel shaft. On the surface of this drum core are laid flat coils of insulated wire wound on formers, and laid on side by side, so as to clothe the drum with a layer of insulated wire coils. The ends of these flat coils of wire are bent over the flat ends of the drum, the whole set being secured by wire binding (see Fig. 31). The number of coils on the drum is equal to the number of radial magnetic field poles. The coils on each half of the drum surface are joined in series and the two series connected in parallel, the diametral terminal wires coming to collecting rings on the shaft. The armature can be easily removed for repairs by lifting the upper half of the ring-shaped iron frame of the field, and then taking the armature and shaft out of the bearings. These bearings are ball-bearings, a section of which is shown in Fig. 32, and oil is fed from sight-feed oil cups to them, and, working out into a drip pan, flows thence into a tank cast in the hollow base of the dynamo, from which it can be drawn off and reused. The dynamo rests on a cast-iron base, and has the necessary belt-tightening arrangements.

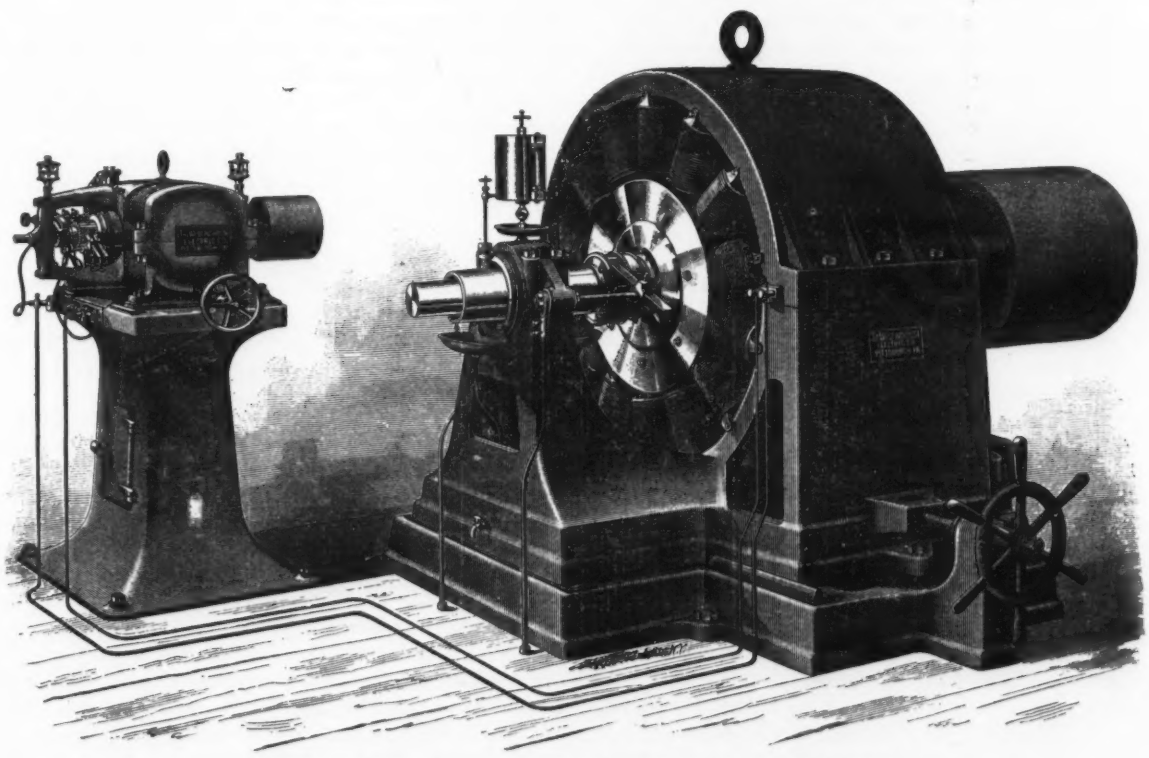


FIG. 30.—WESTINGHOUSE ALTERNATOR AND EXCITER.

This dynamo is manufactured in five sizes—

No. 0,	500-lights,	floor space 4 ft. 2 in. × 5 ft.
No. 1,	750-lights,	floor space 5 ft. 2 in. × 5 ft. 6 in.
No. 2,	1,500-lights,	floor space 7 ft. 4 in. × 7 ft.
No. 3,	3,000-lights,	floor space 8 ft. × 7 ft. 6 in.
No. 4,	6,000-lights,	floor space 11 ft. × 8 ft. 4 in.

The capacity being reckoned in 16 c. p. lamps.

In large stations, in place of having an exciter for each machine, it is usual to excite an entire battery of dynamos from one or two large exciters driven by separate engines.

The armatures of these dynamos are all wound to deliver current at 1,000 volts. On the 750-light size the total weight of copper on the armature is 16 pounds, and as it is disposed in a single layer on the surface of the drum it is readily kept cool and well insulated.

The leading-out wires from the collectors are carried on lugs on the main-bearing caps. The number of complete periods per second, or the frequency of the alternation of the current, is 130, or 8,000 per minute. Hence there are 16,000 alternations or reversals of current per minute. The usual speed of revolution is 1,000 per minute. In the No. 3 size, which is a commonly adopted central station size, there are 16 magnet poles projecting inwards from the frame. The exciting coils of these magnets are joined up in two series of eight coils, on the upper and lower halves of the ring frame respectively, and the two series of magnet coils are joined up in parallel. These magnets are excited by a continuous current of about 25 to 30 amperes, supplied at 100 volts. The armature coils are joined up in a like manner.

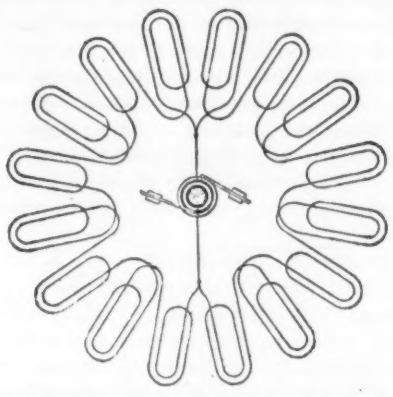


FIG. 33 A.—DIAGRAM OF WINDING OF WESTINGHOUSE ALTERNATOR.

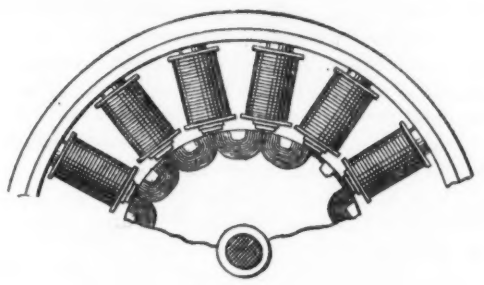


FIG. 33 B.

The diagram in Fig. 33A* will indicate the manner in which these armature coils are connected, and Fig. 33B will show how the ends of the flat armature coils are turned over the flat end of the drum core to get them out of the way. The centre of the flat coil is occupied by a wooden lathe or core, and a narrow wood slip is inserted between adjacent coils. The whole armature when clothed with coils is wound round with steel piano wire. The clearance space between the surface of the wire and the end surface of the magnet poles is very small. Hence the wire moves in a very strong field. In operating a battery of central-station dynamos, the whole of the field circuits of the alternators are joined in parallel with the armature circuits of one or more exciting dynamos operated by independent engines, the field circuit of each alternator being controlled by a double-pole switch on the switchboard.

(To be continued.)

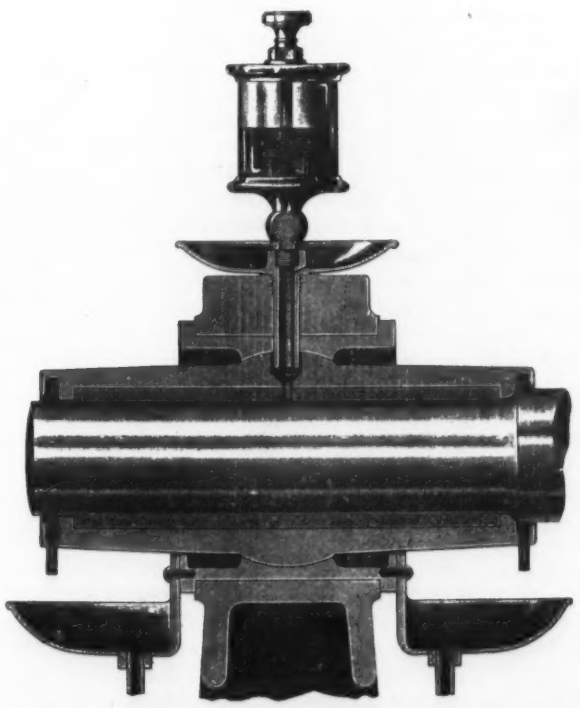


FIG. 32.—BALL BEARINGS OF ALTERNATOR.

* Continued from THE ELECTRICAL WORLD, Sept. 6, 1890.

* These diagrams are from the British specification, No. 9,726, of 1887. See also Brit. Spec., No. 9,725, of 1887.

The Central Lighting Station as an Investment.*

BY B. E. SUNNY.

The central lighting station has been the subject of many lectures. It has been discussed from an electrical, mechanical and geographical standpoint, until there is not much left to say about it. Everybody knows now what kind of apparatus to use, what steam plant to put in, and where he had better locate his central station. If he don't know, all that he need do is to tell the editor of his newspaper that he is thinking about embarking in the electric lighting business, with strict injunctions as to secrecy, and before he knows what has happened he will be surrounded with a galaxy of dapper young electricians from the nearest big city, all brimming with wise suggestions and advice. If he escape them—well, there is no use of discussing improbabilities.

Central stations, from an investor's standpoint, have not been discussed to any extent, however; and as I have had the opportunity of knowing the financial side of many of them, I may be able to make a few suggestions of interest. While both the arc and incandescent light are young, they are old enough to give an account of themselves as money makers. They are not in their "infancy" as so many suggest, but are almost 10 years old, and should stand or fall by the record they have made during that period.

It may not be amiss to refer at this time and in a brief way to the introduction of these two forms of light to commercial and domestic use. The arc lamp found a clear field, with practically no competition for out-door and store lighting, and was immediately installed in all large cities, to permanently replace the gas and oil lamps that for so many years had quite indifferently performed the service. The additional cost at that time charged for arc lights as compared with gas was very great, but only in proportion, however, to the increased amount of light. Price was of secondary importance, as compared with the great demand for a means of making the stores and thoroughfares as bright by night as they were by day. The arc lamp became at once a popular and permanent adjunct in the service of the community, and as years have come and gone, it has become more firmly intrenched, so that it is now indispensable. While there are a few small towns in the country that have escaped the vigilance or resisted the wiles of the electric light man, history fails to record a single instance where the arc lamp has been discarded and the old methods of lighting substituted.

When we consider what the arc lamp is, it is obvious beyond all doubt that it is the best light that has ever been known. Brilliant, steady, noiseless; absolutely reliable, and at the same time cheap; it is permanent, and notwithstanding the inventive age in which we live, it will shine on for years into the future. There is no possible substitute for it as it is used now, and while we hear of the prospective betterment of this thing and that, how seldom we hear anybody suggest that there is soon to be a better light than the first-class arc lamp of to-day! The experimental stage has been passed, except as to minor details, and what we have now will stand the scrutiny and defy the inventive genius of the next decade.

The incandescent light has had a hard fight for a position in the commercial and domestic world. Coming after the arc light, it has met the latter in competition for store lighting, and has felt the opposition of cheap gas and cheaper oil, in many instances difficult to overcome—especially in house lighting in a community where a small difference in price determined the choice of illuminants. Notwithstanding the fierce competition, the incandescent light has become a fixed factor, with a future before it that its most enthusiastic admirer is more likely to underestimate. Safe, clean, beautiful, and above all free from the injurious effects to health that are induced by the use of gas and oil as illuminants, there is only the incidental competition of gas and oil, that will be less and less as years go by, to retard it in its march to supremacy in the lighting world.

It seems an inflexible and unvarying rule of the universe that we shall suffer, to a greater or less extent, injury to persons and property through the imperfections of several great agencies in the service of the community. Every means by which a large class of people are benefited calls for tribute, in the shape of annoyance, loss and injury, because of its failure to do that for which it is designed uninterruptedly, reliably and perfectly. If we will go over the list of public corporations and analyze the advantages and disadvantages growing out of the service they perform, we will find this true in every instance.

The water-works is a priceless boon, an indispensable public servant, but how often is the water, so generously distributed, so contaminated with impurities that it causes epidemics and frightful mortality. It is only a short time since that the water furnished in this city was the subject of bitter complaint by the press and the people, notwithstanding we have the greatest sheet of pure water in the world by our side. The gas-works perform a service of equal importance with the water-works, but its imperfections are evidenced in the blackened walls and ceilings, the vitiated atmosphere, the suffocating of ignorant or careless users and the dangers of fire. The sewerage system, so vitally necessary and important, frequently fails in its work of doing good always, and turns its attention to decimating the population. The telegraph and telephone, the great time savers in this age where time is precious, vex us to the soul with their shortcomings, that seem to be beyond the power of man to prevent or cure. The steam railway, performing the greatest public service, furnishes a column of disasters in the daily papers, and even the slow going street car, with plenty of time to be perfect in the performance of its duty is imperfect, in that it kills so much time in doing its work. If its sanguinary exploits ended in killing time alone, it would not be so bad, but it occasionally extends its field of operations to children and old ladies.

So it goes through the whole list, and we can contemplate with the greatest satisfaction the almost perfect service of the electric light, and its greater freedom from the annoyances and losses to those whom it serves than the agencies enumerated. True, it has contributed to a small extent, in comparison with its large work, to the fatalities and losses that the community must suffer for employing these public servants, but the circumstances in each case of injury or mortality have invariably been of an extraordinary character, and capable of permanent correction.

In connection with the success and permanency of the electric light, it can be said that no one recognizes the future of electric lighting more than our friends in the gas companies, more than 300 of whom are operating electric lights in connection with their gas works. The gas directory says that the gas companies are operating 32,000 arc lights and 140,000 incandescent. If it could be known in how many instances the individual owners of the gas property are also the owners of the electric light plant, it would be found that the number of electric lights in control of the gas companies is double the number shown.

In one year, from March, 1889, to 1890, the gas companies increased their ownership in electric lights to the extent of almost 50 per cent., indicating their faith in a most gratifying way in the earning power and permanency of the electric light. If statistics showing the growth of the gas business during the past five years were available, I think it could be shown that the increase in gas consumption is nominal as compared with the growth in population, and that aside from the large cities, where the difficulty in stringing wires has retarded the electric light, the gas business has only changed with respect to the adoption of cheaper methods of manufacture, so as to compete with electricity. In the smaller cities, towns and villages the electric light is available for every store and home, however remote, because of the inexpensive means that can be used for complete distribution.

The number of electric light companies operating in the United States is, according to recent reports, 1,483 against 968 gas plants. This great difference is owing to the large original outlay for a gas company as compared with an electric lighting plant. The former, with its heavy iron pipes buried in the earth, subject to heavy leakage and frequent expenditures for repairs, can only cover a limited territory, and yet calls for an investment fivefold greater than the electric plant. The electric plant, because of the great saving in the original investment, is invariably given the preference by investors, as is also the same with the electric railway as compared with the cable railway. Recent figures show 238 electric railways as against 44 cable railways in operation in the United States, while the latter has been in practical operation six years and the electric railway half that time.

It is a self-evident fact, therefore, that the electric light is an absolutely permanent and growing investment; that it has taken its place in the large cities side by side with the great public corporations, contributing its quota to the general service and comfort. By the excellent methods developed with such speed and skill the individual is served with light or power, regardless of quantity, little or much, and just as his convenience may dictate. It is under perfect control; is readily adaptable to the varying conditions of the demands, and on the whole calls for no extraordinary skill to operate. Above all, the price at which it can be produced, and that at which it can be sold, leave a margin of profit that ought to be satisfactory. So far, then, we find that the electric light is: First, a commercial success; second, that it is permanently installed in the service of the public; third, that its imperfections are less than those attached to any public service.

I have gone over the condition of the business quite fully for the purpose of impressing you with the fact of its indisputable permanency. It is firmly lodged among the commercial enterprises, and has been for seven or more years. Now, the important thing to get at is, how does its record read from the investor's standpoint? Does it rank with the water-works, the gas works, the telegraph and the steam railway as a producer of dividends? Unquestionably it does. All who are familiar with the operations of lighting plants can bear testimony to the fact, notwithstanding the grave mistakes that have been made in planning for and furnishing the service, and which have materially lessened the net financial results. With the one possible exception of the telephone, the future of no business has been more greatly underestimated than the electric light. The telephone people—and I was with them for several years—blundered on the growth of the business with the greatest unanimity, and built everything too small. The electric light people did the same thing, and now the face of the earth is dotted with lighting properties, which were poorly planned, badly built and indifferently managed. I have classed the lighting station with the water-works, gas plant and other quasi public institutions in the importance of the service rendered and as to financial results, but in the matter of construction, I am sorry to say that the average lighting station is inferior. Where do we ever find a pumping station in other than a neat substantial brick building rather than in a frame shell covered with tar paper or tin? True, there are many lighting stations expensively and durably constructed, but we can all point out a long list, located in cellars, basements, abandoned barns and cheap wooden structures, with the usual and customary trimmings of second-hand boilers, an engine too old for service in a saw mill and underwriters wire. Of course such a plant is a cheap one, and it is within the means of almost any man to start one, but with what results? Excessive running expenses and a succession of break-downs and repair bills until the profits are eaten up and there is nothing left for the owners but to abandon the property or sell out to some one who will reconstruct the plant on a proper basis.

This is one type of non-dividend paying lighting station. Another is the station that is well built, of brick or stone, with good steam plant and electrical apparatus, and starts off on its career with the applause of its projectors and patrons. It is a great success, and the patrons increase, until the fact is brought home to the owners that they have left no room for more boilers, more engines and electrical apparatus, and that to meet the additional wants they must add to the building and machinery, put up another stack and re-enforce their pole line. Then begins the work that ends in the central station becoming an exhibition of engineering gymnastics. Engines of various makes are crowded in spaces too small for them, high speed and low speed, big boilers and little ones, until the station takes on so many peculiarities that a change of engineers is apt to shut it down until the new man can unravel the awful mystery. The remarkable thing about such a station is that it generally pays good dividends, for the reason that every boiler, engine and dynamo is worked to its fullest capacity and consequently under economical conditions. So long as the machinery stands the strain the stockholders will have cause to rejoice, and it is at this juncture that they would be glad to have the demand for lights cease. In the nature of things, however, it is just at this point where the demand becomes particularly pressing, and the stockholders are confronted with the necessity of rebuilding in its entirety a station but two or three years old, too small for the reasonable demands made upon it. The rebuilding means the throwing away of the old station in many instances, the selling off at a great sacrifice the smaller engines and boilers to make room for larger types and the absolute loss of the labor and material in foundation setting, steam fittings, etc. The shares of stock representing the cost of the property abandoned, continue, however, to be an obligation upon which dividends must be paid. Then during the transition period, while part of the work is being performed from the old station and part from the new, the increase in the operating expenses caused by two sets of men, and the disorganized condition of affairs, is very marked. It generally happens, too, that, in their desire to make the new one a model station, the manager or superintendent devotes all of his time and attention to that work, and leaves the old station to the boys to run, with the usual results. This is the type of station that changes from a good dividend payer to one that for a time at least quits paying, and then resumes—or if its capital is increased to take care of the rebuilding, it can continue its dividends during rebuilding, but on a smaller basis, because of the additional number of shares. There are but few central stations in the country that have not already, or must within a short time, go through such an experience.

The remedy is old, and naturally occurs to any one of moderate experience. It involves at the outset the selection of a larger lot and the construction of a larger building than we can at the time see any possible use for. There seems to be no reasonable limit to the demands that may be made for facilities, so that reasonable methods of planning do not seem applicable. A larger lot and building does not call for an excessive increase in cost over what a smaller property would cost. In fact, the real estate and building are generally the smaller items in the original expenditure. If, then, the boiler room, engine and dynamo rooms are planned for indefinite extension, according to the generous proportions of the building, not with reference to the growth of the next three or four years, but of the next 15 or 20 years, and the machinery selected be of a standard type and capable of duplication from year to year, the sacrificing of original investment would stop. There are some who calculate the depreciation on the machinery of a lighting station at 10 per cent., but many will agree that the estimate is excessive. There is no reason why boilers, engines and dynamos, with reasonable care and the occasional renewal of parts subjected to heavy wear, should not last 20 years. I refer to standard apparatus, of course, and do not include experimental types that are, or ought to be, thrown out after a brief use because of their inefficiency. Now if we start out right, with plenty of room with standard machinery, and the territory that we have is good, the increase is sure to come, and can be cared for gradually by the addition of a boiler, an engine, or a

*Paper read at the Chicago Electric Club meeting, Monday, Oct. 20, 1890.

dynamo, without throwing away any part of the original investment until it is worn out. The whole secret of dividend-paying enterprises is in their ability to run reliably every day and every year without subjecting the machinery to excessive and abnormal demands, and in the avoidance of rebuilding or abandoning original investments. There is no lighting property to-day that can not pay a regular dividend and earn enough above it to add to the plant as the demand may require.

There is no fixed rule as to the dimensions of a station building that will serve the wants of its patrons, present and prospective. The growth of the business has heretofore been beyond the calculations of the most enthusiastic. The same statement is true with the telegraph and telephone. The Western Union officials are building additions on their already mammoth structure in New York that will increase the facilities four fold. The great telephone building on Courtlandt street, designed four years ago to furnish all the service below Canal street, is inadequate to meet the demands. The telephone building in Chicago, but three years old, is badly crowded, while in the electric light branch of the service, the Arc Light Company and the Edison Company, in Chicago, have, after two years' operations, exhausted their facilities for extending in their present quarters. Rebuilding is in process, or under consideration, at Omaha, Denver, Milwaukee and other cities in the West.

We cannot complain of this most prosperous condition of affairs. Rather do we congratulate ourselves on the increasing growth in population, which does not come to large cities only, but to the small ones, and to the towns and villages all over the greatest nation that the world ever knew.

With the increased number of people comes the increased demand for everything, and what, more than light—and the electric light at that. Is it not wise, therefore, to pattern after the most substantial and permanent institutions of the time, and build, not for the present and the immediate future, but for twenty-five or more years ahead of us. What is now standard may be obsolete ten years hence, but at the same time standards are slow to change, and with the economical and efficient boilers, engines and electrical apparatus of to-day we are safe to embark in great and important investments and leave the almost impossible task of improving on what we now have to take care of itself.

THE ELECTRIX SINGLE POLE SWITCH.

The Electrix Single Pole Switch.

This switch, the mechanism of which is shown in the accompanying illustration, is the result of careful study and a very large experience in the actual use of all the different appliances of a similar character. It embodies a positive double make-and-break movement and all the contact-carrying parts are of soft metal unaffected by heat. The electrical connection is made through a solid bar of metal without hinges or rivets and the fastening screws are soldered in place.

The base is made only of porcelain, which is recognized as a thoroughly efficient and suitable insulating material for devices of this character. The cover and all exterior portions of the switch are absolutely insulated from the current-carrying parts.

The novel departure of the Electrix Company which manufactures this switch is the making of the porcelain bases of different colors, as black, brown, cherry, etc., also to imitate marble, with metal covers to match so that the switches can be used in connection with the most artistic interior. The working of the switch will readily be understood from the accompanying illustration.

The Foote Intermediate Speed Regulator.

Much of the success of an electrical plant, whether for the purpose of lighting or for power, depends on the uniformity of the speed that is given to the dynamo shaft; and not only does an irregular speed produce unsatisfactory results in giving flickering lights or unreliable power, but the entire plant, including lamps, motors and the dynamos themselves, is subject to serious injury or destruction whenever the speed produced is too great and the current thereby produced too intense.

The greatest advantage of this regulator for dynamos is that any source of power, however irregular, may be used satisfactorily. Water-wheels regulated by it will furnish very economical and thoroughly satisfactory lights, and a great economy in lamps, brushes and commutators will probably be realized, as the dynamo cannot race under any circumstances. In many street railroad plants the economy of water power as against steam means the success or failure of the road. Owing to the great change of load there must necessarily be, from the fact of the cars sometimes all running, and sometimes nearly all being at a standstill, the best water-wheel governors will not suffice to keep the speed of a dynamo within the desired limits. If a number of cars happen to be started at the same time, the load is so great for that moment that the dynamo requires much more power to keep it up to its normal speed, and the best water-wheel governor will not act sufficiently quick to counteract the effect. This regulator must, from its construction, always maintain the same speed for which it has been adjusted, and automatically it taxes the driving power to the exact extent that is required to perform its work with.

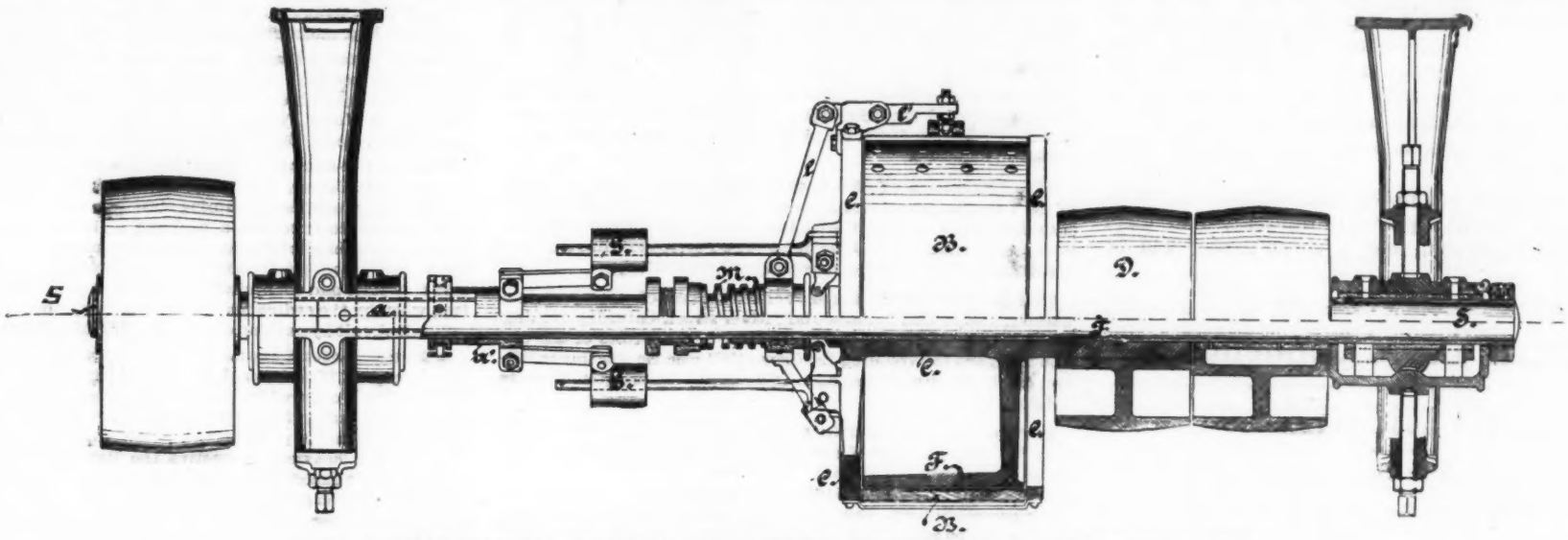


FIG. 1.—LONGITUDINAL SECTION OF FOOTE'S INTERMEDIATE SPEED REGULATOR.

The main features of the regulator are a friction coupling between the driving pulley and the shaft to be driven and a governor which controls the pressure of the friction. Fig. 1 shows a side elevation which is partly sectional and represents the regulator in the form of a countershaft, as this has been found to be the most convenient way of applying it to any kind of machinery. It can thus be placed on the floor or hung from the ceiling, to suit circumstances.

Fig. 2 is from a photograph of one of the machines as it appears ready to be placed.

In Fig. 1 the driving pulley is marked *D*, and is fast on the projecting sleeve of friction wheel *F*, the two forming one member of the friction coupling and rotating freely on the shaft *S S*. The other member of the friction coupling consists of three brake-shoes, *B*, which cover two-thirds of the friction wheel and are made of leather, backed with wood and sheet steel, which latter projects beyond the shoe, serving to fasten the same to the carrier *C*, and giving the necessary elasticity to the shoe.

The brake-shoes *B* are forced against the friction wheel *F* by the spring *M*, which acts through levers *l* and *l'*, levers *l'* having their fulcrums on the carrier *C*, which is fast to shaft *S S*, so that they all rotate together. The arms of the governor *G G* at their fulcrums have each an extension at right angles, which press against the spring *M*, so as to diminish the pressure of the same on the combination of levers *l* and *l'* and brake-shoes *B*. The relative tension of the spring *M*, and the amount of the weights on the arms of the governor are determined and adjusted according to the horse power and the speed that are desired. This relation being adjusted, and the speed of driver *D* being in excess of that required for shaft *S S*, the action of the regulator is as follows:

The arms of governor *G G*, at the predetermined speed, assume a position forming a certain angle with the shaft, and reduce the pressure of brake shoes *B* on friction wheel *F* to a certain amount, and this angle cannot change, nor consequently can the pressure on *F*, as will be seen subsequently, so long as the speed of *F* remains greater than that of shaft *S S*, for which the machine is adjusted. As the pressure of *B* upon *F* depends upon the position of governor *G G*, so the position of governor *G G* depends upon the speed of shaft *S S*, and again this very speed of shaft *S S* depends upon the pressure of brake-shoes *B* upon friction wheel *F*—so that we have three actions, pressure, centrifugal power and revolution, forming a circle in which each depends directly from its predecessor and controls the next one. These three actions are constant and therefore simultaneous, and are so linked together that the tendency of one to vary from its predetermined condition causes the other two to react upon itself in direct opposition to its original tendency.

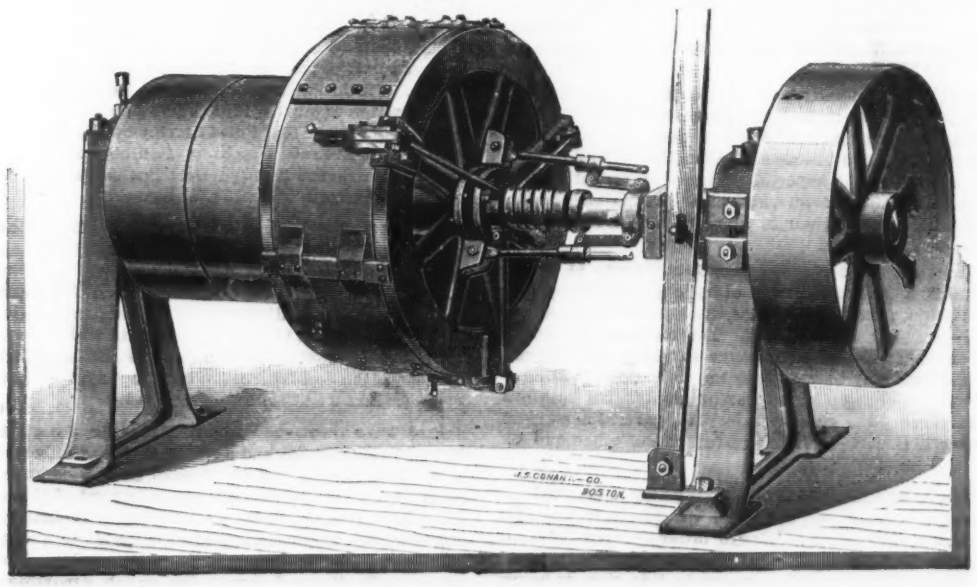


FIG. 2.—FOOTE'S SPEED REGULATOR.

Let us suppose, for example, that the pressure of the brake-shoes *B* on friction wheel *F* were increased ten per cent., the speed of shaft *S S* would thereby be increased in the same proportion. This increase of speed again would increase the action of the centrifugal power and throw out the arms of the governor ten per cent. beyond their normal angle, and here the counteraction would take effect, for the arms of the governor in flying out act directly upon the spring *M* and diminish the pressure of shoes *B* on wheel *F*. The weights of the governor and the tension of the spring being properly adjusted, the counteraction reducing the amount of pressure must be exactly equal to the increase of pressure that caused it, and both being simultaneous, neither can take effect, so that the result is perfectly

uniform speed. The shipper *a a'*, which changes the position of the weights on the governor, is an addition to our regulator, which increases its value in many places. By altering the distance of the weights from the fulcrum of a governor, the action of the same is greatly changed, and we thus obtain for our machine a change of speed of over thirty per cent. while it is in motion, and still any speed it is placed at will be maintained without variation.

In factories and business buildings, which have power for manufacturing purposes or for running elevators, this regulator will make it practicable to put in an electric light plant, to be run by the power that already exists, thus making the cost of installation much less than where a separate high-speed engine has to be provided, and precluding the necessity of having to hire an extra man to attend to the engine. The cost of running such a plant would be the additional amount of fuel that is needed to produce the two or three horse power necessary, according to the number of lights wanted, and by adding a storage battery, connected by an automatic switch, a surplus of current can always be ready for an emergency, when the full power of the engine is required elsewhere, so that the dynamo can be stopped in such cases, and the lights continue as usual.

Dynamos for power and for lighting may be run from the same shaft, when the power is transmitted to them through these regulators, and a great saving will be realized.

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Oct. 20, 1890.

Mr. G. W. Walker, of the Walker Electric Company, 50 Broadway, returned last week from Paris, where he had his meters in competition with all the principal meters of Europe and the United States.

The Eureka Electric Company, 18 Broadway, is rewiring the Manhattan Bank building, 40 Wall street, for 1,000 lights, using two 400-light Loomis dynamos and two Beck engines. This company is doing an extensive business in electric lighting.

Mr. James B. Olsen, city salesman of the New York Insulated Wire Company, secured an order last week from the Eureka Electric Company for 40,000 feet of Grimshaw "White Core." This wire is to be placed in the Manhattan Bank Building, 40 Wall Street, this city.

Lieut. Bradley A. Fiske will read a paper before the New York Electrical Society at Columbia College, on Thursday evening, on "The Modern Electrician in Time of War." A large attendance is expected, as the subject is one of great interest, and it will be treated from an entirely new standpoint.

Mr. Henry Hine, general district agent of the Westinghouse Company, has recently sold a 750-light alternating current incandescent and 60-light alternating current arc plant to the Oswego Gas Light Company, Oswego, N. Y. This plant is to be operated by water power, and the gas company proposes to push the electrical part of its business with vigor.

Chas. H. Disbrow, of 2 West Fourteenth street, this city, keeps on hand a great variety of second-hand electrical arc light apparatus, only slightly used, and is constantly furnishing machines of various capacities to those who need this kind of apparatus. Any machines that parties wish to dispose of will be placed upon the market by Mr. Disbrow.

The Crosby Electric Company is just fitting up its new salesrooms and offices, 87-89 South Fifth avenue, this city, where arrangements are being made to show every conceivable appliance that can be run by open circuit batteries. Mr. F. M. Archer, the secretary of the company, and superintendent of manufactures, is highly pleased with the new quarters, and with the assistance of Mr. Louis Walsh and Charles Puterbaugh, whose name was incorrectly given last week in our columns.

National Electric Manufacturing Company, 14 Vesey street, has installed a 280-room Porter electric messenger system in the Kenmore Hotel, Albany. The new Dunlop Hotel, Albany, is having an 80-number annunciator put in. This company is furnishing a 400-number Porter electric messenger to the Coates House, Kansas City. The company is very busy on its standard annunciators in numbers from four up to several hundreds. Its Splitdorf insulated wire is having an extensive sale. It is carried in stock in all numbers from 10 B. & S. to 38; also a full line of office and annunciator wire.

The New York Insulated Wire Company has received an order for 28 miles of Nos. 1 and 6 B. & S. Grimshaw white core wire to be shipped to Havana; also a large order for assorted sizes of white core wires for Vera Cruz. The New Jersey Central Railroad building, corner West and Liberty streets, this city, is being wired throughout with this company's wires, the installation being made by the United States Electric Lighting Company, with Mr. W. Hall in charge. The new World Building, which is to have 4,000 lights, is also being wired, the work being in charge of W. H. Tucker.

Visitors at the Electric Exchange.—The following names were taken from the register of the Electric Exchange of the "A. B. C." firm: This firm will be pleased to have all out-of-town electrical people call and make use of this exchange while in town. Writing materials are placed at the disposal of visitors. Next week the exchange will be elegantly fitted up in upholstered furniture, with a post office to receive and distribute mail for all who desire to avail themselves of the exchange, free of all expense. The visitors were: A. W. Butterworth, Brooklyn, N. Y.; H. F. Adams, Atlantic City, N. J.; W. R. Brixey, Seymour, Conn.; C. N. Knox, Hartford, Conn.; W. B. McDonald, Ft. Wayne, Ind.; Chas. J. Fox, Philadelphia, Pa.; J. W. Carter, Brooklyn, N. Y.; A. E. Rich; J. C. Davidson, Princes Bay, New York; Chas. Daw, New York; A. C. Shaw, Boston; C. A. Hanuthy, Watertown, Conn.; H. D. Stanley, Bridgeport, Conn.; F. W. Potter, Nantucket Electric Light Company; W. C. Bryant, Bridgeport, Conn.; H. T. Clark; J. R. Magee, Boston; S. S. Leonard, Chicago; W. C. Miller, Albany, N. Y.; T. M. Hart, New Bedford; Joseph Allen, Newark, N. J.; C. F. Parmley, New York; D. C. Spruand, Philadelphia, Pa.; A. H. Rennie, Brooklyn; E. Ward Wilkins, Philadelphia; G. S. Stevens, Boston; E. F. Lewis, Lawrence, Mass.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, Oct. 18, 1890.

The "Elihu Thomson" is the name selected for a new iron steamer, recently launched by Messrs. Sprague & Breed, of Lynn, Mass.

Mr. P. B. Downing, son of Jefferson Downing of this city, has sold his electric car switch to the Lewis & Fowler Manufacturing Company, of Brooklyn, for 10 per cent. royalty.

President Whitney, of the West End Road, says that as soon as the East Cambridge bridge is opened a line of electric cars will be started from East Cambridge to Bay View, City Point.

A Large Owner of Westinghouse Stock.—The Boston *Post* says that President Charles Francis Adams, of the Union Pacific, is the largest Boston owner of Westinghouse Electric stock

Ball Game.—About 1,000 spectators witnessed the ball game on the West Lynn (Mass.) grounds Saturday afternoon, when the Thomson-Houston "Electrics" outplayed the "Woven Hose," of Cambridge.

Extension of Plant.—At a meeting of the Norwalk & South Norwalk (Conn.) Electric Light Company it was voted to expend $35,000 in the extension of the plant, $25,000 for new machinery and $10,000 on buildings.

The Directors of the Springfield (Mass.) Street Railway Company met last Monday and voted to call a meeting of stockholders to ask that the capital stock of $400,000 be doubled, so as to use electricity on all the lines. The Forest Park line has used the single trolley system one season very successfully.

The Lower Mills Improvement Association, of Dorchester, met at Odd Fellows' Hall, River street, Saturday evening. A committee was appointed to look after the interests of the section in regard to extending the Grove Hall electric car line to Milton, and to try to secure electric lights along Washington street to Milton.

A New Massachusetts Company.—Arrangements are on foot for the formation of a company for the manufacture of electrical apparatus and appliances at Pittsfield, Mass., with a proposed capital stock of $25,000. The company will manufacture electrical machinery, and it is probable that application for a charter will be made within a week or two. The persons interested in forming the company are yet undecided where they will locate.

Electric Cars with Smoking Compartments.—It is said that the new electric power plant of the Naumkeag Street Railway Company, at Salem, Mass., will be one of the finest in the country. Some $300,000 will be expended on the plant. A car house 280 feet long will be erected, and there will be a carpenter and repair shop. New palace cars 30 feet long with ladies' compartment and gentlemen's smoking compartment are to be a novelty in the street car service.

New Britain, Conn.—The recently organized syndicate of stockholders of the Anglo-American Electric Light Company met in Kensington, Conn., last week. There were 15 present, representing a majority of the stock. It was decided to offer the property to the city of Meriden for $35,000. The following officers and board of directors were elected: William W. Norton, president; Willis Upson, secretary and treasurer; Elam S. Kilby, Frank Wilcox and John Boyle, board of directors.

A new rosette cut-out, invented by J. H. Coombs, is on exhibition at his office, 146 Franklin street. Mr. Coombs claims that this cut-out will "beat the world." During the exhibition, which lasted nearly half an hour, the rosette was entirely submerged in water and when taken out did not show any sign of a leak. Many prominent gentlemen attended the exhibit and expressed themselves as much pleased. This cut-out will be made of porcelain when put upon the market.

A Proposed Electric Line.—An effort is being made, with good prospect of success to establish an electric railroad in the town of Winthrop, Mass., to connect with the South Ferry at East Boston. Men of means have the enterprise in hand. The proposed route is said to be from Point Shirley by the way of Shirley street, Washington avenue, Winthrop, Pauline and Pleasant streets to Main street, thence through East Boston to the ferry. The storage battery system will probably be used.

Election of Officers.—The following officers have been elected by the stockholders of the Eastern Electrical Supply and Construction Company: M. W. Brown, president; Albert Otis Smith, treasurer; M. W. Brown, Albert Otis Smith, C. Fred Hutchinson, L. A. Dean and Samuel Mosely, directors. This company has just filled a large order to be shipped to Paris, included in which was a large number of Burnby dry batteries. Mr. Henry F. Kellogg, formerly with the Thomson-Houston International Company, has connected himself with this house and is now on the road.

The Thomson-Houston Electric Company's Mail.—Mr. A. L. Rohrer has had a count of the number of pieces of mail going and coming for two weeks at the company's factory at Lynn, and the result was as follows: Inward—Letters, 3,290; papers, magazines, etc., 415; packages, 14. Outward—Letters, 2,653; papers, 189; packages, 69; total number of pieces, 6,630. Two messengers are kept busy going between the post office and the factory. All mail not specially directed goes to the supply department, and is afterwards distributed where it naturally belongs.

Election of Officers.—At the annual meeting of the stockholders of the Schuyler Electric Company, held in the office of the company in Middletown, Conn., on Thursday, Oct. 9, the following gentlemen were chosen directors: S. H. Butler, John N. Camp, Walter B. Hubbard and C. E. Jackson, of Middletown; C. N. Wayland and C. L. Buckingham, of New York, and Chas. E. Dustin, of Hartford. A meeting of the board of directors was held immediately afterward, and officers for the ensuing year were elected as follows: President, Chas. E. Dustin; vice-president, S. H. Butler; treasurer, Jos. T. Elliott; secretary, D. J. Glazier.

Brockton's Electric Road.—The East Side Street Railway Company, of Brockton, Mass., held its annual meeting last week, and of the 268 shares 261 were represented. The following board of directors was chosen: A. C. Thompson, W. C. Flagg and G. H. Kingman, of Brockton; Winthrop Coffin and A. A. Glasier, of Boston, and G. W. Mansfield, of Melrose. The reports of the treasurer and superintendent gave evidence of the prosperity of the road. The company will soon extend its tracks to Whitman, Stoughton, North Easton, Holbrook, Avon and Randolph. Work on the Randolph, Avon and Whitman extensions will begin this fall, and the contracts for the work have already been awarded. The majority of the stock is now held by a Boston syndicate, and it is expected that the road will be extended to other towns than those mentioned, and petitions with that end in view will be presented to the selectmen in the spring.

L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, Oct. 18, 1890.

The Globe Electric Cordage Works have adopted fast colors for their Oehrle flexible cord.

Mr. J. W. Parker has received an order from the Charlottesville and University Electric Light Company, of Charlottesville, Va., for an 80 h. p. Ball engine.

Messrs. Vallee Bros. & Co. have the contract for putting in a 3,000-light plant in the new State House of Refuge which is being completed near Westchester, on the P., W. & B. R. R.

Started on Monday.—The 150 h. p. improved Ball engine in the power plant of the Schuylkill Electric Railway Company, Pottsville, Pa., was put in operation on the 13th inst., and was pronounced a success by the railway people.

Messrs. Geo. H. Dallett & Co. are installing a five h. p. motor for I. E. Walraven for operating a Richards floor winding elevator, a four h. p. portable motor at the Brooklyn Navy Yard to be used in operating a drill connected with a Stow flexible shaft, and a two h. p. motor for Messrs. Morgan Bros, printers.

The Keystone Engine and Machine Works are driven to their full capacity. Last week they placed a 200 h. p. boiler for Joseph Harvey, Fifth and Columbia avenues, a 50 h. p. boiler for Sharpless & Watts, Fifteenth and Chestnut streets, and an 80 h. p. Buckeye engine for Chas. McCall, 621 Cherry street, this city.

The Cutter-Stanley Switch.—A patent has just been granted Mr. Henry B. Cutter, of this city, on an electric switch, which has the following features: "A spring-actuated electric switch adopted to be inserted in a recess in a wall and a pivoted lever for operating the same, in combination with a face-plate for covering said recess and inclosing said switch, and push-buttons passing through said face-plate and connected with the lever of the switch mechanism, whereby the switch may be set in action or operation to make or break circuit by pushing one or the other of said buttons."

A Large Motor Plant.—Two very large cranes are being built at the shops of Wm. Sellers & Co., Philadelphia, for the Baldwin Locomotive Works, which will be operated entirely by electric motors. On each of these cranes will be two 45 h. p. Westinghouse motors, and one 5 h. p. Wenstrom motor, and each will be capable of lifting the heaviest locomotive the Baldwin Company build. The Equitable Electric Railway Construction Company, of Philadelphia, has been given the contract for the entire electrical installation of these motors and the supervision of all the work. Besides the two large 100-ton traveling cranes, there will be a half-dozen jib cranes, each of which will be driven by a Wenstrom slow speed motor. This entire plant, when completed, will be one of the largest electric motor plants ever installed in this country, as it will represent something like 500 or 600 h. p. of motors and dynamos.

A Fine Plant.—The Philadelphia Warehousing and Cold Storage Company has erected a building nine stories high, at a cost of over $500,000, which is equipped with the most modern machinery. The electric plant is an important feature. The building is to be lighted by 900 incandescent lights. Each floor is on an independent circuit, and each room on an independent tap. It is wired throughout with white core Grimshaw insulated wire. The engines and dynamos are placed in an engine room across the street, some 100 feet from the main building, and the mains pass under ground through a tunnel. Two United States dynamos are to be used driven with two Armington & Sims standard engines. The switchboard is to be equipped with magnetic circuit breakers and all necessary instruments. The work will be under the supervision of Wm. McDevitt, Inspector-in-Chief of the Philadelphia Board of Fire Underwriters. There has been a contest over this plant for over three months, the decision only being reached this week.

Two New Philadelphia Plants.—The Fort Wayne Electric Company, through its agent, Mr. G. A. Wilbur, has closed a contract with the Powelton Electric Company, of this city, for the exclusive use of the Wood and Slattery systems in West Philadelphia. The Powelton company is building a handsome station on the Schuylkill, and is to use compound condensing engines of the Fitchburg type and Root water tube boilers. The station will start with apparatus for 2,000 incandescent and 120 arc lights. The Fort Wayne Company has also closed a contract with the Suburban Electric Company for the exclusive use of the Wood and Slattery systems in the Twenty-third ward, embracing Tacony, Homesburg, Bridesburg and Frankford. The Suburban company is building its brick station at Tacony, on the Delaware River, and is to use compound condensing engines of the Fitchburg type and Coatsville return tubular boilers. The company will start the station with 3,000 incandescent and 240 arc lights. These stations will in time be among the largest in the city.

W. F. H.

WESTERN NOTES.

CHICAGO, Ill., Oct. 25, 1890.

Mr. W. H. Bryan, recently secretary of the Heisler Electric Light Company, St. Louis, Mo., has been appointed to the position of manager of the Chicago branch of the Yale & Towne Manufacturing Company, of Stamford, Conn.

Mr. P. L. Rose, manager of the Rose Electric Light Supply Company, of St. Louis, was a welcome visitor in Chicago this week, and secured a car load of second-hand dynamos for shipment to his storehouse, where they will be overhauled and put in readiness for further duty.

A New Type of Motor and Dynamo.—The St. Paul (Minn.) Brass Works Company has begun the manufacture of a new type of motor and dynamo which is said to show a working efficiency of over 90 per cent. as tested with the Prony brake. This type of machine is the invention of Mr. Walther F. Brown, of St. Paul.

A New Company on the Pacific Coast.—The Ukiah (Cal.) Electric Light, Water and Power Company has been incorporated by Frank Euch, William Huffschneider, W. H. H. Graves, James M. Haven, N. W. Griswold, Charles Trautner and H. Gustave Trautner. The capital stock is $50,000, of which $3,800 has been subscribed.

Streator, Ill.—The first electric street car was run in Streator on the 8th inst. over the tracks of the Streator Railway Company. This corporation was organized last spring with a capital of $250,000. P. F. Barr, of St. Paul, is president, and Mr. Walker Miller superintendent. The overhead system is in use, and the generators and motors are of the Thomson-Houston pattern.

Double Carbon Lamp Suit.—A motion for a preliminary injunction against the Municipal Electric Light and Power Company, of St. Louis, Mo., has been filed in the United States Circuit Court by the Brush Electric Company. The motion was supported by three electrical experts to the effect that the electric lamp patented

by J. J. Wood last April is substantially the same as the Brush double carbon lamp.

The Universal Arc Lamp Company, New York, has appointed the Electrical Supply Company, 171 Randolph street, Chicago, its agent for the States of Michigan, Wisconsin, Illinois, Ohio, Kentucky, Indiana, Iowa, Minnesota, Nebraska, North Dakota, South Dakota and Montana, and Manitoba. The St. Louis Electrical Supply Company, 403 North Eighth street, St. Louis, has secured the agency for the following territory: Missouri, Arkansas, Colorado, Indian Territory, Kansas, New Mexico and Texas.

Electrical Instruction at the Michigan Mining School.—The announcement of this school at Houghton, Mich., for the coming year contains the statement that special instruction will be given in the elements of electrical engineering. Special attention will, however, be given to power transmission by electricity for mining work in general, underground lighting, surface and underground haulage, hoisting, pumping, etc.; also power for ore dressing and milling purposes. Mr. Edgar Kidder has charge of the instruction.

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$258@$300	Cumberland	$ 59@ $60
Central Union	55@ 57	Wisconsin	117@ 118
Michigan	95@ 97	Bell of Missouri	155@ 160
Great Southern	32@ 35	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$90@$100	Chicago Edison Co	$130@$132

St. Louis, Mo., Oct. 17, 1890.

Mr. Robb Mackie and Mrs. Mackie, of Fort Wayne, Ind., visited St. Louis this week en route home on their bridal tour.

Dr. A. R. Mason, of Boston, spoke so feelingly of the value of Simplex wire to some St. Louis parties this week that he carried away a very nice order.

Mr. A. C. Fowler, one of the prominent men of St. Louis, and a member of the law firm of Fowler & Fowler, of St. Louis, New York and Washington, has successfully carried through several important patent claims of late.

Mr. Carl Kammeyer, Superintendent of the National Electric Manufacturing Company of Eau Claire, passed Sunday in St. Louis while en route West to close a contract. During his stay a telegram was received that indicated that the company's Eastern agents were by no means idle, and that several "Down East" towns will be furnished with his company's incandescent lights before snow flies.

The Union Electrical Construction Company, Eleventh street, St. Louis, has secured the agency of the Bundy Manufacturing Company's watchman's clock and fire alarm system, and is successfully introducing it throughout the city. The company is also supplying a large number of buildings with handsome electroliers and combination fixtures, and, owing to the high quality of their workmanship, deserves success.

Louisville, Ky., Oct. 18, 1890.

The Gaynor Electric Company has become agent for the Wenstrom motors and dynamos, and has sold the Louisville Leather Company 25 incandescent lights and a 2 h. p. motor.

The Edison General Electric Company are now represented in Louisville by Campbell Scott and Geo. H. Stout. They have sold Col. W. W. Hite two plants of 40 incandescent lights each for his ferry boats.

The Consolidated Street Railroad has bought 100 motors of the Thomson-Houston Electric Company for its new cars. As the Thomson-Houston Company could not furnish generators for the two new power stations within the required time, several Edison generators have been purchased.

New Isolated Lighting Plants.—The Cartwright Wagon Company has placed an order for 270 lights, the R. B. Cotter Lumber Company for 200 incandescent lights and Hugh Stafford, of the Star Cooperage Works, a part of which was recently destroyed by fire, for 50 lights. The Standard Oil Company, whose chief southern branch is located here, has ordered a complete electric light equipment for the oil refinery at South Louisville, the buildings and grounds of which occupy about five acres.

Thomas H. Fearey, manager of the Louisville office of the Central Thomson-Houston Company, has just made the following sales: R. B. Cotter Lumber Company, 200 lights; New Albany (Ind.) Rail Mill, 30 arcs; Louisville Public Warehouse, 5 h. p. motor; Baptist Book Concern, 3 h. p. motor. He has just completed a plant of 50 arcs and 100 incandescents in the new buildings of Bamberger, Bloom & Co. Some new features were introduced in the arc light wiring which give added security and elegance and elicited the praise of Mr. Smith, the insurance inspector. He is constructing also for the Dupont Paper Mill a plant of 50 lights, and for the steamer "Joe Fowler," of the Evansville and Paducah Packet Company, three arc lights.

Electric Power from Street Railway Lines.—The Consolidated Street Car Lines propose to furnish power to all those along their lines desiring it. They propose to tap the overhead trolley wires either to furnish power for manufacturing establishments or to run electric light dynamos. Mr. B. Du Pont, one of the largest stockholders in the Consolidated Lines, will be the first to enjoy the innovation of an electric light plant in his private residence operated by the current from the overhead wires. As the Consolidated Lines have a large excess of horse power at their power houses, they have demonstrated to themselves that they can furnish power cheaply at a fair profit. In fact, one contract has already been let by which a manufacturing establishment gets 15 horse power at $800 a year, which is between $50 and $55 per horse power per annum.

San Francisco, Cal., Oct. 16, 1890.

The Electrical Engineering Company, of San Francisco, working under the Keith patent, is crowded with orders for motors, and will soon be obliged to move into larger quarters in order to keep up with the constantly increasing demand for its motors. The superintendent says the company is three months behind its orders now.

To Install a Mining Plant.—The Washington Coal and Lumber Company, of Oakland, Cal., whose mines are in Washington, intends soon to put up a complete electric plant for power and light. The company is now considering the subject of electric coal diggers. Information concerning the plant can be had from the secretary of the company.

A Young Superintendent.—The Pacific Power Company, of San Francisco, Cal., has perhaps the youngest superintendent of any electric power company in the United States. The plant, which consists of four 40 h. p. Keith generators, furnishing current for 45 motors varying from ⅙ to 20 h. p. on two five-mile circuits, is under the sole supervision of G. W. Fisher, who is but 17 years of age. His brother Harry, aged 20, is his assistant.

Cincinnati, O., Oct. 17, 1890.

The estate of the late A. D. Bullock, the first president of the Cincinnati Telephone Company, and a heavy stockholder in electric companies, is estimated to be worth over $2,000,000. It is left to the widow and two sons.

The Edison General Electric Company has just obtained from the Board of Public Improvements, of Cincinnati, permission to lay conduits in the business portion of the city. But the permission is given on condition that the company shall proceed at once, to satisfy the Board that the concern is working in good faith and really intends to do business. Some six months ago, after half a dozen different companies had secured franchises from the city, there was suddenly a great combine made, and all except one of the companies were gathered in by the Cincinnati Gas Light and Coke Company. The Edison Company staid out and the gas company has used every means possible to prevent a rival from gaining any headway. Ex-Gov. Foraker, for the Edison Company, secured, by an action in the Probate Court, the franchise for laying the conduits, the Board of Public Improvements only having the right to supervise the plans so as to preserve the property of the city from damage. It is quite certain now that the Edison Company will soon be operating in Cincinnati. Ex-Gov. Foraker states that the proposition for the sale of the site of the plant has already been sent to New York for approval. The company is endeavoring to secure a lot 100 × 100 feet in the best location in the city. The Cincinnati Electric Light Company's stock is quoted at 160. It is held by the Cincinnati Gas Light and Coke Company, a corporation worth $13,000,000.

F. de L.

SOUTHERN NOTES.

Norfolk, Va., Oct. 18, 1890.

Beaumont, Tex.—A company is being organized to build and operate an electrical railway.

Raleigh, N. C.—An isolated electric light plant is being placed in the new cotton factory.

Plaquemine, La.—The city council is negotiating for the establishment of an electric light plant.

Orlando, Fla.—Parties are arranging to erect an electric light plant for the purpose of lighting the streets.

Atlanta, Ga.—An isolated electric light plant will be put in the furniture factory of Messrs. Boyd & Baxter.

Grand Rivers, Ky.—The development company has contracted for the erection of an electric light plant.

Columbus, Ga.—The Columbus Street Railway Company is preparing to adopt electricity as its motive power.

Gadsden, Ala.—The Gadsden and Attalla Dummy Line will change its motive power from steam to electricity.

Cedartown, Ga.—An electric light plant will be established by the Cedartown Land and Improvement Company.

Lake Charles, La.—An isolated incandescent electric light plant has been put into the establishment of M. T. Jones & Co.

A New Telephone Line.—Work has begun on the construction of a telephone line between Athens, Ga., and Winterville, Ga.

Mt. Airy, N. C.—W. Duke, H. C. Cooper, S. T. Griffith and others have reorganized a company to erect an electric light plant.

Richmond, Va.—The newly-completed electric railway of the Richmond & Manchester Railway Company commenced running to-day.

Norfolk, Va.—A company has been organized to build and operate an electrical railway to a new suburb of Norfolk, soon to be platted off.

Athens, Ga.—J. T. Voss, the superintendent of the Athens Street Railway, states that his road will soon adopt electricity as a motive power.

Chattanooga, Tenn.—M. M. Henderson, C. S. Henry and others are organizing a company to build and operate an electric street railway.

Athens, Ga.—The Gamewell Fire Alarm Company is putting in a fire alarm system, and the work is being superintended by Mr. Gamewell himself.

St. Augustine, Fla.—The St. Augustine Belt Line Railway Company has been incorporated with a capital of $75,000 to construct an electrical railway.

Georgetown, Tex.—A company will probably be organized to build and operate a street railway, and electricity will doubtless be chosen as the motive power.

Chattanooga, Tenn.—The Chattanooga Electric Street Railway Company is preparing to enlarge its plant, and has already placed its order for additional machinery.

Waxahachie, Tex.—The plant of the Waxahachie Electric Light Company is to be enlarged by the addition of new machinery. The capital stock of the company is to be increased to $18,000.

Moving an Electric Light Plant.—The work of moving the electric light plant at Richmond, Va., took place one day last week. The new power house is at the corner of Seventh and Canal streets.

Augusta, Ga.—The *Chronicle* recently made a trade review of the city for the past year, in which it was shown that 26 miles of electric railroad have been built and put in operation during the last 12 months.

Roanoke, Va.—A new development company, of which Arthur C. Denniston is president, has been organized to improve suburban property, and will erect an electric light plant and construct an electric street railway.

Dawson, Ga.—The city council has contracted with the Edison Electric Light Company to furnish the city with a system of electric lights, consisting of 85 lamps, and the same are to be in operation within 60 days.

La Grange, Ga.—A bill is being prepared to be introduced at the approaching session of the State Legislature providing for the issue of $50,000 of bonds for the purpose of establishing an electric light plant and a water works system.

Greenville, Tex.—The city government will erect an electric light plant with a capacity of 100 lights of 50 c. p. each for street lighting, and 700 lights of 16 c. p. each for commercial purposes. The Mayor, R. L. Porter, is now securing estimates on the cost of the necessary equipment.

Norfolk, Va.—The Mayor of the city has issued a proclamation which reads: "Whereas the globes of the electric lights are liable to be broken by the placing of cotton bales against them, and thereby rendering the lights dangerous, I forbid the placing of bales of cotton nearer than 10 feet to any electric light pole bearing a light, and hereby instruct the police to see that this order is enforced."

San Antonio, Tex.—The San Antonio Street Railway Company began operating its system with electricity on the 8th inst. This is one of the most extensive and best equipped electric roads in the South. It embraces 40 miles of track, while franchises have been received and work begun on 20 additional miles.

Gadsden, Ala.—The Gadsden Land and Improvement Company, operating eight miles of dummy line, proposes changing the same into an electric railway. This company has a capital stock of $3,000,000, and the officers are: President, J. L. Tanner; vice-president, Opal Christopher; secretary and treasurer, M. L. Foster.

Wilmington, N. C.—The Wilmington street railway has been purchased by E. L. Hawks and others, and the present motive power will give place to electricity. Mr. Hawks is now in New York purchasing an electrical equipment for the road. Captain J. H. Barnard, of Asheville, N. C., will superintend the putting in of the electric plant.

Richmond, Va.—Dr. W. Leigh Burton has been on a two weeks' business trip through the Northwest, in which he visited St. Paul and other cities. He declined to say whether or not it was true as reported that a Northern syndicate was negotiating for the purchase of a controlling interest in the stock of the Burton Electric Heater Company.

Texarkana, Ark.—The electric light plant and gas works have been absorbed by a new company just organized with $200,000 capital stock. It will be known as the Texarkana Gas and Electric Railway Company. Additional dynamos are to be added. The street railway has also been purchased, and will be transformed into an electric road at a cost of $40,000.

Baton Rouge, La.—The Citizens' Electric Light Company is the new name of the Baton Rouge Electric Light and Power Company which has been reorganized, with O. B. Steele, president; U. Wax, vice-president, and W. J. Knox, treasurer. The new company will shortly place their order for a duplicate equipment to be brought into play in the event of accidents to their present plant.

Macon, Ga.—E. F. Fuller, representing a New York syndicate, is examining the electric light plant and other property owned and operated by George F. Work, of Philadelphia, with a view of purchasing for the syndicate. The electric plant consists of two distinct systems, the Brush by the tower system, and the other by the Thomson-Houston, for both arc and incandescent lights. These two plants are valued at $100,000.

Y. N. B.

ENGLISH NOTES.

(*From our own Correspondent.*)

London, Oct. 8, 1890.

Sir William Thomson's Meter.—A little disappointment was felt at the meeting of the British Association when it was found that Sir William Thomson's new meter was as large as an old-fashioned eight-day clock, and required winding up every 24 hours. The instrument is, however, confessedly in an early stage, and is likely to be considerably modified. It is one of the sample-taking type. A counter train with an integrating wheel is suspended from a lever which forms one arm of a balance resembling the well-known current balance of the same inventor. A drum whose cylindrical surface is cut away in such a fashion that it rolls against the integrating wheel for a short period when a small current flows, and a longer period when a heavy current is passing, revolves by clock work below the counter. A number of ingenious details are to be found in the instrument, which is undoubtedly accurate, though at present rather expensive and troublesome.

The Rating of Incandescent Lamps.—I notice that your Institute of Electrical Engineers has appointed a committee to co-operate with one appointed by the National Electric Light Association to report on a proper basis for the rating of incandescent lamps, with a view of securing more uniformity in this respect. In England, manufacturers who supply lamps marked, say "16 c. p.," presumably refer to the Board of Trade candle, though in view of the fact that these standard candles sometimes vary by as much as 10 per cent., the consumer who brought an action against a lamp manufacturer on the ground that his lamps were under candle-power, would indeed be a bold litigant. The Board of Trade, in their electric lighting orders and regulations, are very careful to insure that the consumers shall be supplied with his due amount of "electric energy," but leave the remedy entirely in his own hands in the event of his not being supplied with his due amount of electric light.

The Lane-Fox Distribution Patent.—The Lane-Fox patent, No. 3,988, of 1878, which its owners assert covers the employment of secondary batteries, as "reservoirs of electricity," in conjunction with lamps run in parallel across constant-potential mains, is again to the fore. Some three months ago an attempt was made by the Lane Fox Electrical Company to levy a royalty of 1d. per Board of Trade unit (1,000 watt-hours) on various metropolitan supply companies, but in face of the formation of a defense association and of the evident determination of the supply people not to be coerced into the payment of this 14 per cent. royalty, the matter was dropped. I now learn, however, that a writ has been served to-day on the Kensington & Knightsbridge Company and on their consulting engineer, Mr. R. E. Crompton, and that the Lane-Fox people have briefed the two best counsel at the bar, Sir Richard Webster, Q. C., and Mr. Fletcher Moulton, Q. C. This policy of harassing supply companies by means of a long-forgotten patent has aroused a feeling of considerable irritation, but for the existence of which the companies would, no doubt, be inclined to submit to this tax, which, even in the case of the largest companies, would not amount to more than a few hundred pounds per annum during a period of two years. Indeed, the possible gain in royalties is so insignificant and the life of the patent is so nearly over, that it is difficult to understand why the patent was ever resuscitated.

Municipal Lighting.—The *Times* opened its columns this week to an "occasional correspondent," who holds forth at great length on the subject of "The Middleman in Electric Lighting." This occasional correspondent seems to have just discovered what has long been insisted on by the technical press, namely, that the evident favoritism shown to local authorities by the Board of Trade in the matter of the granting of electric lighting orders constitutes a serious bar to progress. What with the 42-years' purchase clause, the low price of gas, the severity of the Board of Trade regulations and the inertia of the general public, the conditions under which electric lighting has to be carried out in this country are already sufficiently onerous, and the free and easy manner in which orders are granted to municipal authorities, and the wide powers that are vested in them, tend to still further delay sound progress. The conditions which many municipalities seek to impose on companies desirous of working municipal franchises are such that no prudent investor would care to place his money in such concerns. As a consequence speculative enterprises are fostered, and the rate-payers, whose interests the municipalities profess to have at heart, will probably in the end have to pay considerably more over this electric lighting question than they otherwise would. This view of the matter i

indeed forcing itself even upon the local authorities themselves, and within the last few days the town councils of two such widely different towns as Leeds and Exeter have passed resolutions to the effect that the Electric-lighting Acts sufficiently safeguard the interests of the rate-payers, and therefore it is inadvisable for the local authority to embark on an electric-lighting scheme.

News of the Week.

THE TELEGRAPH.

Telegraph Service in Boston Interrupted.—A telegram from Boston, dated Oct. 19, says: The crossing of an electric light wire and a Western Union wire in the Western Union telegraph office in this city, at 6 o'clock to-night, caused the burning out of all the wires running from the switchboard in the operating room and led to a slight fire. The flames spread in the woodwork of the tower, and fears of a serious fire were entertained for a time. They were extinguished, however, and only slight damage was done to the building, which is a brick structure, at 109 State street. The wires were so badly mixed up that the Boston office was practically isolated all the evening.

THE TELEPHONE.

More Stock.—Bell Telephone stock is going to be increased, according to Boston despatches, in order to provide funds to extend the long distance telephone system.

Long Distance Line in England.—The London to Manchester trunk telephone line, which is now completed and will shortly be opened to the public, is 206 miles in length. During a recent trial the spectators at the London end were able to hear part of the performance at the Princess's Theatre, Manchester, while those at the Manchester end were treated to a portion of the "Gondoliers" at the Savoy Theatre, London.

The Erie Company's Extensions.—The Boston News Bureau says that with the close of the present season the sub-companies of the Erie Telephone will have completed over six miles of underground conduit covering the thickly settled portions of the cities of St. Paul, Minneapolis and Cleveland. Into the conduits have been drawn nearly 70,000 feet of 120-wire cable. In addition to the above work, the Minneapolis, St. Paul and Cleveland offices have been equipped with the latest improved multiple switchboards at a cost of $50,000, the old boards having been remodeled and shipped to smaller exchanges. The cost of the underground work and new switches will be about $150,000. The management has provided for this unusual outlay by an increase of the capital stock of the sub-companies, the Erie and American Bell companies taking and paying for their respective proportions of the increase.

THE ELECTRIC LIGHT.

Mr. Wm. Oswald, manager of the Southern Electrical Manufacturing and Supply Company Limited, New Orleans, La., has sold a 135-light Edison plant to Mr. W. H. Price, Acadia Plantation; a 135-light Edison plant to Mr. Hanlon, Eureka Plantation, and a 350-light Mather plant to Mr. I. M. Schulherr, Meridian, Miss.

Two New Westinghouse Plants.—The Westinghouse Electric & Manufacturing Company has contracted to furnish the alternate current system in a new central station at Durango, Cal., a plant with 750 lights capacity, and at Orange, N. J., the Westinghouse company is also going to install a plant with its apparatus for 750 lights.

Lincoln, Neb., where the Lincoln Electric Light and Power Company has now been operating the Westinghouse alternating current system in a central station plant of 1,950 lights capacity, will also have more light shortly, the company having just concluded a contract with the Westinghouse company for apparatus to operate 1,500 16 c. p. incandescent lamps.

Lighting the Air Brake Factory.—The new works of the Westinghouse Air Brake Company at Wilmerding are brilliantly illuminated by the Westinghouse alternating current system of arc lighting. The lights are supplied by the Turtle Creek Valley Electric Light Company, which has recently installed a Westinghouse alternating current incandescent and arc light plant.

Electric Lamps in Sweden.—Some 20 electric lamps illuminated the car in which the remains of John Ericsson rested while proceeding with great honors through a large part of Sweden. The car was draped in black, ornamented with silver. It was open on all sides, and over the whole was raised, on corner columns, an arched canopy, in the ceiling of which the electric lamps were scattered among decorations of silver stars.

Mast Arms Ordered.—The Allegheny City Council has been authorized to contract with the Westinghouse Electric and Manufacturing Company for 100 O'Beirne mast arms and 100 alternate current arc lamps to be used as an addition to the system of tower lighting at present in use in that city. The lighting by towers is said to have proved in some degree a disappointment, and the citizens welcome this new move on the part of the officials.

Cheaper Lights for Lowell, Mass.—The mayor and committee on lighting have been authorized to make a contract with the Lowell Electric Light Company for three years, to furnish 200 lights at 40 cents per light, and additional lights at 37½ cents per light. Under the contract now expiring the city has paid 50 cents per night for 177 lights, and last year paid $20,336 for electric lights in streets and $2,088 for electric lights in public buildings. The new contract is to date from Aug. 1.

Mr. D. A. Tompkins, of Charlotte, N. C., who is largely identified with a number of engineering schemes and represents the Westinghouse Electric & Manufacturing Company in the southeastern States, was a visitor to Pittsburgh last week. Mr. Tompkins has recently sold for his company a number of plants for central station lighting in the State of Georgia and he reports that the South is not one whit behind the North in appreciating the fact that electricity furnishes the ideal illumination.

Cohasset, Mass.—At a meeting of the stockholders of the Cohasset Electric Company last week the board of directors was enlarged to five members by the addition of Silas Pierce, of Scituate, and J. C. Howe, of Cohasset. The plant and system were formally turned over to the company by its original charter members and builders, M. V. Morrill and H. N. Bates. The company has received several applications for lighting of stores and residences, and also for the extension of the street lighting system into North Scituate.

Mr. C. G. Barfoot, electrician of the Albany (Ga.) Edison Illuminating Company, who is also the agent for the New American Electrical Arc Light Company, of New York, and the Riker Electric Motor Company, of Brooklyn, has recently secured an exclusive franchise for the supply of electric light, heat and power in the city of Dawson, Ga., and is to furnish 10 arc lights of 2,000 c. p. each, at $100 each, and 75 incandescent lights of 25 c. p. each, at $20 per lamp per year, and the contract covers a period of 20 years. Additional arc lights are to be furnished at $100 per year each, and incandescent lights at $20 per year. A right of way is granted through all streets, roads, squares and alleys of the city. Mr. Barfoot desires to correspond with parties desiring to make a good investment.

The Consolidated Electric Storage Company gives in concise language ten reasons why persons should use storage batteries in connection with present isolated plants, as follows: (1) It will be more economical; your operating expenses will be less. (2) Your service will be improved. (3) Your service will be continuous, furnishing light at any hour of the day or night without the necessity of starting a fire or sending for your engineer. (4) There is no other way to accomplish this most desirable and essential end (in the absence of a central station) without storage batteries. (5) You can increase the number of lights on your circuit from 100 to 200 per cent., depending on the number of hours you are running at present, without increasing your plant. (6) You can utilize an arc circuit during the day to charge batteries, thus doubling the efficiency without increasing the capital invested. (7) You will avoid the awkward predicament of being left in darkness in case of accident or a breakdown. (8) Your light will be steady and uniform. (9) Your lamps (an important item of expense) will last twice as long. (10) Your plant will be complete.

APPLICATIONS OF POWER.

Wilkesbarre, Pa.—It is reported that a party of New York capitalists are taking over the entire street car system of Wilkesbarre, Pa. They have secured options on a majority of the stock of the horse and electric railways. An electric plant will be constructed to supply the motive power of the entire system.

Extension of Jersey City Electric Line.—The Jersey City (N. J.) electric railroad is to be extended to the ferries. Up to this time only one mile of the road at its extreme western end has been operated by electricity, but the Common Council has now given permission to the company to extend its overhead wires to the ferries.

Long Street Cars.—The West End Street Railway Company, of Boston, is having made a large number of very long cars. They will measure 35 feet over all the bodies, being 25 feet long. They will be equipped for the Thomson-Houston system, and are to be delivered during October, November and December. The makers are J. M. Jones & Sons, of Troy, N. Y.

Hoisting by Electricity.—An electrical hoist has been placed on the new Neave building at the corner of Fourth and Race streets, Cincinnati, O. The current is furnished from the Edison plant and the hoist is used for raising the heavy pillars, columns and beams used in the construction of the building from the ground to the positions which they are to occupy in the structure.

New Accumulator Cars.—The Accumulator Company, of this city, has just closed a contract with the Dubuque Street Railway Company, Dubuque, for six Edco cars, operated by the accumulator system. This contract was made after President Rhomberg, of the Dubuque Street Railway Company, had made an exhaustive test of the system for three months. It is the intention of Mr. Rhomberg to equip his whole road with accumulator cars.

The United States Telpherage Patent.—In The Electrical World of Oct. 11 an abstract was given of a decision recently rendered in the United States Patent Office, awarding priority of invention of the Telpher system to Fleming Jenkin. Mr. Rudolph M. Hunter, of Philadelphia, with whose patent application Mr. Jenkin's patent was brought into interference, informs us that the case has been appealed, and pending the decision on this appeal the ownership of the broad patent of the series railway is an open question.

Atlanta, Ga.—On the fifteenth of the present month a large force of hands commenced work grading the right of way for the new electric line from Atlanta to Fort McPherson, a distance of five miles. The name of the company is the Atlanta, West End & Fort McPherson Street Railway Company, and the officers are: B. F. Abbott, president; J. H. Mountain, vice-president; H. L. Woodward, secretary and treasurer. The Edison system has been chosen, the contract having been entered into with Morris Slattery, the Atlanta representative of that concern. It is stated that it is designed to make Atlanta the central distributing point for the business of that company. The line is to be in operation in three months from the commencement of work. Before deciding upon the Edison-Sprague system, the gentlemen of the company visited Nashville and Augusta, where that system is used, and thoroughly investigated it.

Electricity in a Silver Mine.—Since the operation of electric machinery of the Westinghouse manufacture has been such a wonderful success in several Pennsylvania coal mines, the demand for that company's apparatus is rapidly increasing and its fame has even extended to the large mining districts of Colorado. The result of this has been that the Westinghouse Company is now engaged in manufacturing power apparatus for the operation of a silver mine owned by the Gold King Mining Company, of Telluride, Col., Mr. L. A. Nunn, of that city, being the president of the company. The mine in question is situated on the top of a mountain about 2,000 feet high, and as the cost of coal is a great factor in the operation of a mine under such circumstances, the advantages of electric power over steam can be easily appreciated. At the foot of this mountain is a very strong waterfall, and this power the mining company intends to utilize in conjunction with the electrical apparatus. It has been decided to place the electric plant containing apparatus to generate 100-h. p. near this waterfall, and by this means the power is to be transmitted to the motors at the summit of the mountains, where the mining operations are being conducted.

New Thomson-Houston Electric Railway Work.—During the past two months the Thomson-Houston Electric Company has been actively engaged in completing the construction of, and putting in operation electric railways at Concord, N. H.; Shreveport, La.; Newark, N. J.; St. Paul, Minn.; Memphis, Tenn.; Anaconda, Ont.; Helena, Mont. These roads comprise 50 motor cars and 33.54 miles of track. The St. Paul road was put in operation on Oct. 6, 1890, and has been running satisfactorily ever since. The Concord Horse Railroad, Concord, N. H., eight cars and 7 miles of track, was started Oct. 8, the trial car having on board the officials of the road, and invited guests. Everything in the working of the system was excellent, and the best of results are anticipated by the officials of the road. The road of the Shreveport Land and Improvement Company, Shreveport, La., four cars and 5.25 miles of track, was put in operation Oct. 4, and opens up for residence a large territory owned by the Shreveport Land Company. The initial run was made without an accident of any kind, every car being utilized, and working to the entire satisfaction of all present. The City and Suburban Railway, Memphis, Tenn., five cars and five miles of track, was formally opened Oct. 6, 1890, in the presence of about 500 people. The cars all worked well, and their operation on daily schedule time since the time of starting, has convinced the residents of Memphis that the benefits of rapid transit have in no sense been exaggerated. On Oct. 4 the city of Newark turned its back on horse car traction, and inaugurated a new system which is working to the entire satisfaction of those interested in the road, and the public as well. The trial trip was a complete success. The company has equipped 5.75 miles of track, and has 20 cars in operation. The people are very enthusiastic over the new method of transit, and predict a grand success for the electric cars in the future. On Aug. 2 the Thomson-Houston Electric Company commenced the equipment of the Alamo Street Railway, San Antonio, Tex., and on Sept. 25, in less than two months, had laid 10 miles of track, put up the overhead construction, and had 10 cars in operation, to the entire satisfaction of all parties concerned. It will be seen that this was remarkably quick time, and only goes to show that the Thomson-Houston Company employs thoroughly competent men in its railway department.

MISCELLANEOUS NOTES.

The Writing Telegraph, owned by the Writing Telegraph Company, of New York, has been one of the greatest attractions at the Pittsburgh exposition this season. No one passes it by without examination, and without number and of great variety are the comments made concerning it by the people of different minds.

Instruction in Electricity.—The second annual course of lectures by Henry H. Wiegand, of Johns Hopkins University, began Oct. 3 in the Physical Lecture Room of the Friends' High School, in Baltimore. These lectures are devoted to instruction in the fundamental principles of electricity, and are adapted to the wants of those whose business brings them daily in contact with its practical applications.

Quotations on Electrical Stocks.—Mr. F. Z. Maguire, electrical securities, of 18 Wall street, this city, reports the following quotations of Saturday, Oct. 18, from New York, Boston, Washington and Pittsburgh:

NEW YORK.

	Bid.		Bid.
W. U. Tel. Co.	81¾	Edison Gen. Elec. Co.	96
American Tele. & Cable	83	Edison Gen. Co. Def'd	86
Cent'l & So. Amer.	155*	Consol'd Elec. Lt. Co.	.....
Mexican	208*	Edison Illn'g Co., N. Y.	70*
Com. Cable Co.	.....	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	39	North Am. Phon'gph.	...

BOSTON.

	Bid.		Bid.
Thomson-Houston	51¾	Ft. Wayne Co.	12
" Pref'd	26¾	Am. Bell	222
" Series C.	11¼	Erie	50½
" " D.	6⅜	New England	52½
" Int. Co.	.....	Mexican	.85
Thomson Welding Co.	180	Trop. American	.....
Thomson Eu. Welding	71	Edison Phon'gph Doll	2

WASHINGTON.

	Bid.		Bid.
Penna. Telephone	25	Eck. & Sold. Home Elec. Ry.	65⅛
Ches. & Pot. Telephone	68*	Georget'wn & Tenallyt'n.	51
Amer. Graphophone	15		
U. S. Electric Lt. (Wash.)	150		

PITTSBURGH.

	Bid.
Westinghouse Electric Manufacturing Company	.....

*Ex. dividend.

PERSONALS.

Mr. H. Wellman is now the permanent electrician of the Carpenter Electric Light and Power Company, of Catlettsburg, Ky.

Mr. A. S. Morris, of the Westinghouse Electric and Manufacturing Company's laboratory force, was united in marriage Oct. 15 with Miss Elizabeth H. Wood, of Scarborough-on-the-Hudson, N. Y. The best wishes of many friends go with the young people.

Mr. S. S. Leonard, of Chicago, Ill., western manager of the Hill Clutch Works, was in New York last week for a few days. He was called East very suddenly by the death of his father. He has the sympathies of a large circle of friends in the loss he has sustained.

Mr. John J. Carty, electrician of the Metropolitan Telegraph and Telephone Company, of this city, will give a lecture on "Telephony" at one of the monthly meetings of the Young Men's Christian Association, New York. The date fixed for this lecture is Nov. 25.

Mr. William Tregoning, the former superintendent of the Thomson Electric Welding Company's factory at Lynn, Mass., has gone to England to take charge of the European works of the Thomson Electric Welding Company, now being formed in London. Mr. Tregoning is a native of Cornwall, England, but has been in this country for 20 years.

Industrial and Trade Notes.

Mr. H. A. Wilson, of 73 Hudson street, this city, is a part owner in U. S. letters patent Nos. 408,809 and 399,274 for secondary battery electrodes, and is desirous of disposing of his share in these patents.

The Goulds Manufacturing Company has issued a special circular and price list of its new pumps. These include the Goulds triplex suction and force pump, which is adapted to be run by an electric motor. Many other varieties of pumps are also illustrated and very fully described.

The National Electric Manufacturing Company, of Eau Claire, Wis., sends us a four-page circular, describing the National transformer system of incandescent lighting, and giving illustrations of its alternating and direct current dynamos, together with letters of commendation of the system from those who are already using it in various parts of the country.

The Eureka Tempered Copper Company, of North East, Pa., has issued a price list of its commutator segments and brushes made from pure copper. These are adapted either to the Brush,

Thomson-Houston or Western Electric Company's arc or incandescent machines. The company will doubtless be pleased to send this list, together with other information, to all applicants.

The Electrical Supply Company, 171 Randolph street, Chicago, has reprinted in circular form an abstract of an article which appeared in the August issue of the *Northwestern Architect and Improvement Record,* setting forth the advantages of the Habirshaw wires and cables and the interior electrical conduits, for which the Electrical Supply Company is the Western agent.

James H. Mason, of 118 and 120 Park avenue, Brooklyn, has issued an illustrated catalogue, describing "Mason's famous batteries" for electric light and power purposes. This pamphlet describes in detail and gives an itemized estimate of the cost of small plants of various sizes, ranging in price from $7 to $65. The advantages of these plants for the operation of small electric lights and motors are fully set forth, together with considerable information of value to the working electrician.

The Curtis Regulator Company, of 59-63 Beverly street, Boston, Mass., has issued a catalogue and price list of engineering specialties of its manufacture. These include the Curtis pressure regulator for steam and water, the Curtis water pressure regulator, the Curtis expansion trap, the return steam trap, the balanced steam trap, the Curtis patent damper regulator, and other devices of a similar nature. The catalogue contains full descriptions of each, together with names of parties using them.

Messrs. Alexander, Barney & Chapin are showing some electric light cables specially adapted for use in the underground conduits. Two hundred and fifty miles of this cable have been in use in New York City in close proximity to the notorious steam pipes and gas mains for almost two years without a single interruption to the lines. The new "A. B. C." firm is contracting to lay and joint this cable, and with the growing necessity for underground conduits there is sure to be a large demand for it.

The Mason Regulator Company, 10 Central street, Boston, Mass., has very carefully described its various types of regulator in a very neat pamphlet which bears date Oct. 1, 1890. Very good illustrations and descriptions are given of the Mason air brake pump regulator, the Mason reducing valve, the pump pressure regulator, the steam damper regulator, the pump governor, the balance valve, the lever valve and the locomotive reducing valve, together with testimonials from parties who have ascertained by actual use the merits of these various devices.

Magnolia Metal.—The Inman line, running between New York and Liverpool, has had the magnolia metal in use in the journal bearings of its steamships for about three years. Mr. Jas. S. Doran, the superintendent engineer, says: "We have had your metal in use for about three years in various service, some of which is the hardest that I have ever seen anti-friction metal put to, and am free to say that it has given entire satisfaction. It is the best metal for its purpose that I now have knowledge of.'

The Butz Automatic Electric Heat Regulator is fully described in a little pamphlet sent out by A. M. Butz, 154 Lake street, Chicago. As is well known, this regulator can be applied to steam, hot air or hot water apparatus, as desired. The valves require no air pump, air tank or air gauge to operate them. Three electric wires and two cells of battery in combination with a thermostat is all that is required to shut off or turn on steam for direct or indirect radiation and for the perfect regulation of the temperature in residences, public building, hospitals, school-houses, etc.

The McCreary Electrical Specialty Company, of 18 and 20 Cortlandt street, this city, has brought out an advance catalogue of some of its patented reflectors and electrical specialties. Those illustrated are: the reflector shade with mica top, the half reflector shade for incandescent lights, the Bradner adjustable lamp hanger, McCreary's frictional pendant block and socket protector, and McCreary's mica dust protector. A larger and more elaborate catalogue will soon be issued by this company. This will include illustrations and descriptions of many specialties not found in the one already published.

The Writing Telegraph Company, 57 Murray street, this city, is sending out a neatly-printed and nicely-illustrated pamphlet, describing its system of fac-simile telegraphy. This system has been awarded the Elliott-Cresson gold medal of the Franklin Institute, Philadelphia, and the Keith medal of the Royal Society of Arts, Edinburgh, Scotland. Fac-similes of the handwriting of different persons are given in this pamphlet, and the advantages which the system possesses for use under various conditions are fully set forth. A description of the system was given in a recent number of THE ELECTRICAL WORLD.

The Crosby Electric Company, 87-89 South Fifth Avenue, New York, through the courtesy of Mr. Charles W. Kattell, of the Domestic Sewing Machine Company, has secured the use of a sewing machine to exhibit at the American Institute Fair the Hussey Blue Stone battery. Eight of them are charging two cells of the Gibson storage battery, which run the machine at full speed. The exhibit also contains four of the Eclipse batteries. This is the largest battery exhibit at the Fair. Full lines of Eclipse, Blue Stone, Duplex and all sizes of dry batteries in different combinations from two up to 12 for all kinds of work are shown.

The Robinson Radial Car Truck Company, of Boston, Mass., has now in operation, or under construction, for the West End Railway in that city over 50 electric radial cars, such as were described in a recent number of THE ELECTRICAL WORLD, and more than half that number in operation, or under construction, for other railways. The first electric radial car which this company placed on the West End road was put into operation Dec. 4, 1889, and has been running in the regular service ever since. The longest car which this company has on the West End road is a closed car which measures 36 feet 4 inches over all, and seats 42 to 44 passengers.

W. R. Fleming & Co., of 174 Fulton street, New York City, the selling agents for the "Ide" and "Ideal" engines, simple and compound, and other manufactures of the foundry and machine department, Harrisburg, Pa., including steel return tubular boilers, report that they have just closed a large contract for a complete steam plant to go to Mexico. This is the second order on account of the same electric company. Fleming & Co. state that they are having a great run on their engines, particularly the Ideal, which is a centre crank automatic self-oiling engine. It is built very heavy for severe duty, and is in great favor with the electric light and street railroad companies, because of its simplicity, close regulation, and the small amount of care it requires when running. All parts of the engine run in oil and are accessible while the engine is in operation, without the removal of a single bolt or screw.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

E. M. F. of a Gravity Cell.—How many volts does a single cell of Callaud gravity battery give? M. J. M.

The electromotive force of a gravity battery is just over one volt. It varies slightly according to the way the cell is set up, but 1.05 is a very close approximation to the voltage.

A Book for Beginners.—Will you kindly inform me what books it would be best to read in beginning the study of electricity? J. W. J.

S. P. Thompson's "Elementary Lessons in Electricity and Magnetism" is as good a book as there is now available for beginning the study of electricity.

Wiring for Street Railway Plants.—Will you please give the formulæ for calculating wires for a street railway plant, both with double overhead wire and with single overhead wire and rail return? W. J. A.

There are no formulæ applicable to this special problem, but the wiring for the street railway line is designed in precisely the same way as the wiring for any other power plant. The special difficulty is to determine about what the average load will be, which, of course, will depend on the size of your road, severity of the grades and similar factors. Knowing about the average load which you intend to carry, determine the average drop in voltage which you wish to allow, not exceeding 10 per cent. generally. Knowing then the number of ampères that will have to be transmitted to give your average load and length of line, compute the resistance of circuit corresponding to the required loss of potential and then take the size of wire which will give this, by reference to any good wire table. Calculations made on the basis of a double overhead wire will apply fairly well to the rail return, accompanied as it generally is by a metallic circuit.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

To All to Whom these Presents May Come, Know Ye.—By a resolution duly passed by the corporation known as "Hazazer & Stanley," it was voted to change the name of said corporation, with permission of the court, from "Hazazer & Stanley" to "Stanley & Hall."

Now, by order of the Supreme Court, it is made known that from this time the name of said corporation is and shall be "Stanley & Hall." A. F. STANLEY, President.

Intelligent People who are familiar with the respective advantages which are offered by the several competing railroad lines between Chicago, St. Louis and Kansas City, and who desire to travel with the utmost speed, safety and comfort, always take the popular and reliable Chicago & Alton Railroad between these points, and passengers going to or coming from the South, via St. Louis, or when going to or coming from the West, via Kansas City, should insist upon having tickets that read over the Chicago & Alton. It is the only road with three complete and elegantly equipped trains daily between Chicago and each of the points named, and no railroad managers in America have a more intelligent appreciation of the wants of the traveling public than do those of the famous Chicago & Alton.

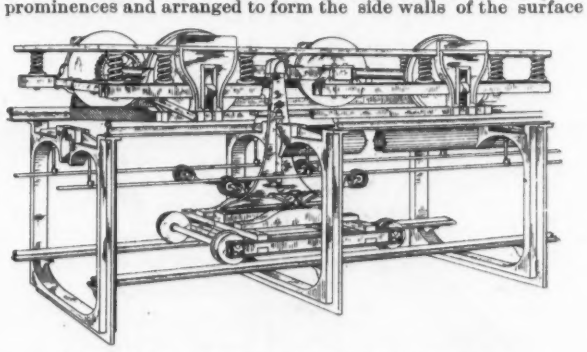
Through Vestibuled and Colonist Sleepers Between Chicago and Tacoma, Wash., and Portland, Ore.—The Wisconsin Central and Northern Pacific lines run through Pullman vestibuled and Colonist sleepers between Chicago and Tacoma Wash., and Portland, Oregon. The train known as the "Pacific Express" leaves the Grand Central Passenger Station, at the corner of Fifth avenue and Harrison street, at 10:45 P. M. daily. For tickets, berths in Pullman or Colonist sleepers, etc., apply to Geo. K. Thompson, City Passenger and Ticket Agent, 205 Clark street, or to F. J. Eddy, Depot Ticket Agent, Grand Central Passenger Station, corner Fifth avenue and Harrison street, Chicago, Ill.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED OCT. 7, 1890.

437,953. Conduit and Electric Conducting Rail therefor; Joseph H. Wehrle, of Newark, N. J. Application filed Jan. 27, 1890. A conduit composed of abutting sections made up of oppositely arranged half sections provided with inwardly and downwardly projecting flanges or walls, which form compartments or chambers in the top of the conduit on both sides of the slot, and each of said half sections provided with a rail section in each chamber.

437,720. Conduit Electric Railway; Ernest M. Reed, of Wichita, Kansas. Application filed March 10th, 1890. In a conduit electric railway, the combination, with the conduit yokes provided with depending prominences, adjacent and inner portion of the surface slot, of concaved plates, secured to the yoke prominences and arranged to form the side walls of the surface



No. 437,720. CONDUIT ELECTRIC RAILWAY.

slot, and as a means for supporting the concrete filling between the yoke frames along the slot sides within the side arches of the conduit.

438,084. Railway Train Signal; Daniel S. McElroy, of New York, N. Y. Application filed Dec. 7, 1889. The invention consists in the combination, with a suitable lantern, of a revolvable plate, an electrically operated escapement for allowing the plate to move through a given portion of a revolution, and a signaling device connected with the escapement of the plate for sending a return signal.

U. S. PATENTS ISSUED OCT. 14, 1890.

438,134. Electric-arc Lamp; Alfred Apps, of London, England. Application filed June 17, 1890. A carbon for electric-arc lamps, having an axial perforation provided with a lining or tube adapted to supply liquid by capillary attraction.

438,145. Regulation and Control of Storage Batteries; Stanley C. Currie, of Philadelphia, Pa., Assignor to the United Gas Improvement Company, of same place. Application filed July 30, 1890. The combination with a main battery of accumulators, of an auxiliary set of accumulators, circuit connections connecting them normally parallel with each other, and in circuit with the main battery, and switch devices whereby each auxiliary cell or battery may be connected in series with the main battery, the remainder of said auxiliary batteries remaining connected in parallel.

438,167. Circuit Closer; Thomas Marcher, of Neumarket, near Neuremberg, Assignor of one-half to Ferdinand Ernecke, of Berlin, Germany. Application filed Jan. 7, 1890. A pivoted tumbler, circuit terminals co-operating therewith, and a hollow rotary downwardly spring pressed cylinder having a screw thread on its under side for actuating the tumbler.

438,192. Electric Motor Car; J. F. Shawhan, of Detroit, Mich., Assignor by direct and mesne assignments to the Shawhan Motor Company, of Michigan. Application filed May 10, 1890. In a motor-car, a truck the axles of which are connected by the equalizing bars, the said bars forming a support for the battery box.

438,204. Electric Motor; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed March 5, 1885. The combination, with an electric motor, of a device responding to changes in the speed of said motor, an electric switch, and an intermediate mechanical clutching or engaging device for operating the switch from the power of the motor, the parts of said device being brought into engagement by a change of speed of the motor.

438,211. Support or Hanger for Trolley Wire; Herbert C. Wirt, of Boston, Massachusetts. Application filed March 12, 1890. The invention in a support or hanger for wires consists of two members, one member being provided with arms extended therefrom, and the other member having a boss or projection to extend up into said opening and provided with a groove or channel to receive the conductor.

438,219. Trolley Pole; Johann M. Andersen, of Boston, Mass. Application filed July 19, 1890. The invention consists in a trolley pole, of a tapering metallic blank bent longitudinally and having edges secured together, the said pole tapered from its top toward its bottom.

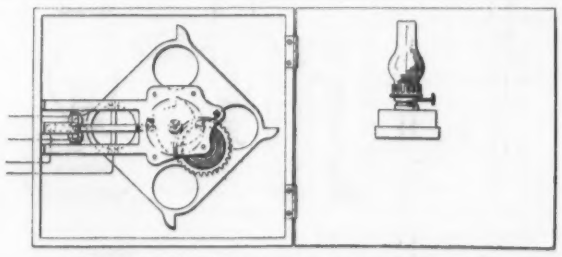
438,226. Apparatus for Measuring the Strength of Electric Currents; Stanley C. C. Currie, of Philadelphia, Pa., Assignor to the United States Gas Improvement Company, of same place. Application filed March 29, 1890. The apparatus consists of an electric current indicator having an armature composed of metallic chips or shavings and silicate of soda.

438,233. Telegraph Instrument; John Geary, of Philadelphia, Pa. Application filed Jan. 11, 1890. This invention consists of an electromagnetic device for telegraph instruments, consisting of one or more similarly wound electromagnets interposed in the main line or line circuit and having one or more adjustable armatures applied to the respective poles thereof and said armatures adapted to make and break either one or both of two series of local circuits.

438.234. Circuit Closer; John Geary, of Philadelphia, Pa. Application filed March 3, 1890. The combination, in a circuit-closing device, of a metal frame provided with a slot, a curved tongue afforded a freedom of movement in or through said slot and attached to said frame by vertical lugs fitting into apertures, a strip of spring metal secured to the frame and contacting with the tongue beyond the point of its suspension with reference to an insulating block, and said strip, while adapted to force said tongue outward, holding said frame and tongue in their relative positions and the said block secured to said frame and strip of spring metal, a contact spring mounted on said block, and an insulating traveler adapted to break the electrical contact between said tongue and contact spring.

438,236. Electric Safe-lock; William H. Hollar, of Elizabeth, New Jersey, and Frederick S. Holmes, of Malden, Mass. Assignors to James W. Torrey, of Merchantville, New Jersey. The combination, with an electrically-actuated combination lock arranged with n a safe or other receptacle and comprising a series of tumblers and a ratchet wheel to operate them, and a polarized electromagnet located in said safe to rotate said ratchet-wheel, of a pole-changer located outside the safe and connected in circuit with said polarized electromagnet, an electric generator connected to said polarized magnet through said pole changer, and a circuit breaker to control the operation of the said magnet.

438,262. Electrical Railway Conduit System; Malone Wheless, of Nashville, Tenn., Assignor by direct and mesne assignments to the Wheless Electric Railway Company, of Alexandria, Va. Application filed Feb. 8, 1890. In an electric railway conduit system, the combination of a power line, a motor line on a car normally out of electrical connection with the power line, and a local circuit, part of which, including the source of electricity, is



No. 438,084.—RAILWAY TRAIN SIGNAL.

on the car, the motor line controlled by the local circuit, and those of the latter controlled by itself and by the power line.

438,293. Electric Railway System; Frank J. Sprague, of New York, N. Y. Application filed Dec. 15, 1885. Divided and this application filed May 21, 1885. In an electric railway system, the combination of a source of electricity, two sets of working-conductors and supplying-conductors connecting said source with both said sets, said supplying conductors forming the only connection between said sets.

438,298. Manufacture of Incandescent Electric Lamps; Thomas A. Edison, of Menlo Park, New Jersey, Assignor to the Edison Electric Light Company, of New York, N. Y. Application filed Dec. 8, 1882. The method of charging the inclosing globe of an incandescing electric lamp with an inert gas, consisting in separating or decomposing within the globe a gas of which such inert gas forms a part and removing the constituents other than the inert gas.

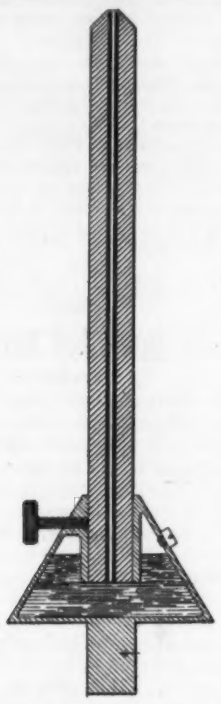
438,299. Manufacture of Carbon Filaments; Thomas A. Edison, of Menlo Park, N. J., Assignor to the Edison Electric Light Company, of New York, N. Y. Application filed March 16, 1883. The method of carbonizing, consisting in heating the carbonizable material in the presence of a substance which gives off a gas other than oxygen to increase the pressure in the carbonizing flask, and maintaining such pressure by heating a similar material in a chamber surrounding said flask.

438,301. System of Electric Lighting; Thomas A. Edison, of Menlo Park, N. J. Application filed June 29, 1883. The combination, with an electric lamp, of cut-out mechanism actuated by cessations of current, one or more shunts around said lamp con-

trolled by said cut-out device, each including a similar lamp, and a constantly closed circuit around said lamp.

438,302. Commutators for Dynamo Electric Machines; Thomas A. Edison, of Menlo Park, N. J. Application filed Oct. 10, 1883. According to the invention the main portion of the commutator consists of a metal cylinder which is keyed to the armature shaft. The conducting-strips are placed upon this cylinder, and mica also between the strips themselves. A metal ring is placed at the end of the cylinder, separated by mica from the conducting strips, to hold the parts, it being secured by a clamping-ring screwed tightly upon it.

438,303. Arc Lamp; Thomas A. Edison, of Menlo Park, New Jersey. Application filed June 10, 1884. In an arc lamp, the combination, with the movable carbon holding device, of an electro-dynamic motor operating the same, said motor having a double



No. 438,134.—Electric Arc Lamps.

differential winding on one part, the two windings being located, respectively, in series with the arc and in a shunt around such arc, and a simple winding upon the other part of the motor located in a shunt around the resistance in the line.

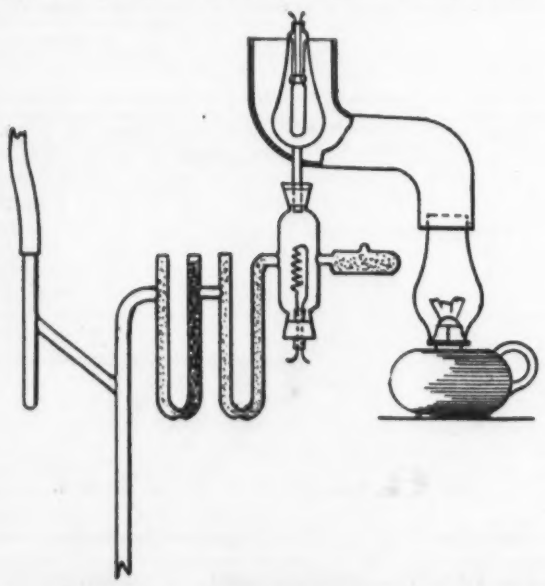
38,304. Electric Signaling Apparatus; Thomas A. Edison, Menlo Park, N. J. Application filed Dec. 15, 1884. The combination, in an individual signaling system, of a line including a source of electricity, a transmitter, and several vibrating receivers, the rates of vibration of which are different each from the other, and a circuit controller at each receiving station having several making and breaking devices, of a number so arranged as to be insufficient to operate any of the vibrating receivers, whereby by a single movement of the controller a plurality of impulses may be sent over the line to the central office signaling device without danger of operating the vibrating receivers.

438,305. Fuse Block; T. A. Edison, of Menlo Park, N. J. Application filed Oct. 14, 1890. The combination, with an insulating receptacle having one or more external insulating flanges of a safety catch supported therein, the terminals of which extend to either end of the receptacle, and free circuit terminals co-operating therewith.

438,306. Telephone; Thomas A. Edison, of Menlo Park, N. J., and Ezra T. Gilliland, of New York, N. Y. Application filed Feb. 19, 1886. In a telephone, the combination, with a diaphragm and an electrode carried thereby, of a loosely supported electrode and a limiting stop therefor rigidly connected with the diaphragm.

438,307. Manufacture of Incandescent Electric Lamps; Thomas A. Edison, of Llewellyn Park, N. J. Application filed July 17, 1886. The method of exhausting incandescent lamps by mercury pumps, which consists in taking up the vapors from the pump by a material placed between the pump and the lamp and taking up the gas or vapor from such material by other materials.

438,308. System of Electrical Distribution; Thomas A. Edison, of Llewellyn Park, New Jersey. Application filed Dec. 6, 1886. In a system of electrical distribution, the combination of a high-tension alternating current generator, a circuit extending



No. 438,307.—Manufacture of Incandescent Lamps.

therefrom, a converter connected with said circuit and supplying current to translating devices, and an electrical indicator not affected by changes in polarity connected with one coil or circuit of the connector.

438,310. Lamp-base; Thomas A. Edison, of Orange, N. J. Application filed May 5, 1890. An incandescent electric lamp-base having, in combination, an externally screw-threaded sleeve permanently connected to one end of incandescing filament, and an inner terminal with a central bore insulated from the first and connected to the other end of the filament.

438,314. Synchronizer for Clocks; Adolphus Gipperich, Richmond, Va. Application filed Aug. 9, 1889. The invention consists in the combination, with the correcting lever or lever arm, of a cam adapted to revolve around the seconds hand arbor, in the combination, with such a cam and the correcting-lever, of an auxiliary lever operating to carry the disc over its dead centre when in this position, relatively to the correcting lever, to allow the latter lever to complete the operation of correcting or setting.

438,326. Automatic Cut-Out; George W. Richardson, of Philadelphia, Pa., Assignor of one-half to Edward D. Gross, of same place. Application filed May 20, 1890. The combination, with an electric circuit including a magnet, of upper and lower armature levers, the upper lever having a hook for engaging the lower one, and electric connections with the lower lever with a stop therefor, whereby upon release of the magnet and upper lever the said circuit will be short circuited through the said lower lever.

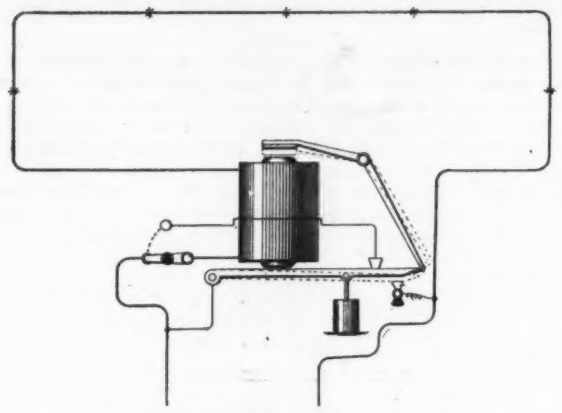
438,344. Circuit Interrupter; Nicholas Chaize and Jacques Chaize, of St. Etienne, France. Application filed Sept. 23, 1889. In a device for opening or interrupting an electric circuit, the combination consisting of a pendulum governor, a bevel gear connected to its vertical spindle, said bevel gear engaging with a second bevel gear mounted upon the driving shaft, and a fulcrumed lever, having one end thereof bearing up against the base of the aforesaid spindle, the other end of said lever carrying a vertical adjustable circuit interrupter, the latter designed to come in contact with a terminal, the whole adapted to open and close an electrical circuit within a suitable fluid contained within a vessel.

438,357. Method of and Apparatus for Magnetic Separation of Ore; John Mabry McMahan, of New York, N. Y., Assignor to John D. Cheever, of same place. Application filed Feb. 20, 1889. The method of separating magnetic from non-magnetic substances in a finely-divided state by feeding the mass across or through a magnetic field and drawing by suction a current of air through the mass while passing through said magnetic field.

438,359. Trolley-wheel for Electrically-propelled Vehicles; Louis Pfingst, of Boston, Mass. Application filed July 14, 1890. In a trolley-wheel, a face-plate provided with a sleeve or socket for the trolley-pole, in combination with a companion plate bolted thereto and a trolley-wheel journaled by ball-bearings between said plates.

438,361. Police Patrol Signal Box; Charles Plumb, of Buffalo, New York. Application filed Oct. 21, 1889. The combination, with a police patrol signal box, of an arm pivoted to the door, having a knob accessible from the outside of the door for operating it, a spring for bringing it to its normal position and a pin for forcing the fast and slow call button of a police patrol signal box in by the act of closing the door.

438,390. Annunciator; Arthur F. Stanley, of New York, N. Y. Application filed May 29, 1890. In an annunciator, the combination with a plate and pivoted armature of a horizontal rod and a

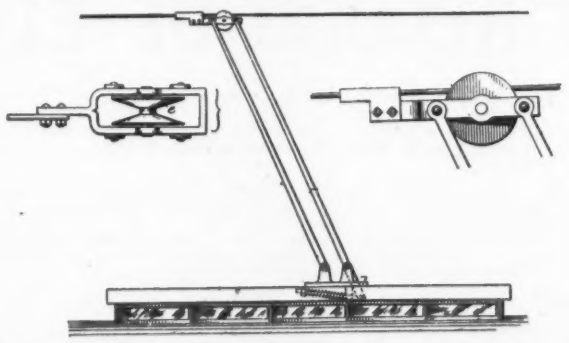


No. 438,326.—Automatic Cut-Out.

drop constructed of a single piece of sheet metal bent to form a card-holder, channel-body, pivot-holes, detents and stop-shoulders.

438,394. Thermal Cut-out; William J. White, of Hartford, Conn. Application filed Jan. 10, 1890. In a cut-out for electric circuits, the combination, with the terminals of a low-tension circuit, of an attenuated fusible conductor completing the circuit between said terminals and a shutter of non-conducting material sustained by said fusible conductor, whereby when the latter is weakened by heat said shutter tends to insure its rupture and to insulate the circuit terminals from one another.

438,400. Connector for Electric Conductors; George J. Bronnan, of Lynn, Assignor, by direct and mesne assignments, to Edward Frost, of Littleton, and Arthur W. Tufts, of Boston, Mass. Application filed Feb. 5, 1890. The invention is embodied in a connector composed of a loop-shaped socket-piece of moderately malleable material having parallel wire-receiving sockets a



No. 438,404.—Contact for Overhead Electric Railways.

short distance apart and connected by a slot formed in the body of the socket piece and extending to the walls of the sockets.

438,404. Contact for Overhead Electric Railways; Albert H. Chadbourne, of Philadelphia, Pennsylvania. Application filed July 9, 1890. The combination, in a contact for overhead electric railways, of the supported frame, a guide-wheel resting against the wire, and a contact brush or plate adapted to bear against the side of the wire.

438,406. Method of Utilizing Electricity in the Formation of Sheet-Metal Articles; Mark W. Dewey, of Syracuse, N. Y., Assignor to the Dewey Corporation, of same place. Application filed May 17, 1890. The invention consists in electrically heating the metal sheet, preferably by passing an electric current through the same before and while said sheet is formed over or within a die or mold by pressure and suitably applied.

438,407 and 438,408. Apparatus for Forming or Shaping Sheet Metal Electrically; Mark W. Dewey, of Syracuse, New York, Assignor to the Dewey Corporation, of same place. Applications filed July 28, 1890. In an electric apparatus for forming sheet metal articles, the combination, with a die or mold, of means for holding and rotating said die or mold with the sheet of metal to be operated upon connections to pass an electric current through the sheet while it is rotated, and means for imparting pressure to the sheet to conform the same to the surface of said die or mold.

438,409. Method of Utilizing Electricity in the formation of Metallic Cartridge-cases; Mark W Dewey, of Syracuse, New York, Assignor to the Dewey Corporation, of same place. Application filed May 17, 1890. Divided and this application filed August 8, 1890. The invention consists in electrically heating the metal to be formed into the case, preferably by passing an electric heating-current through the same before or while the case is formed or before its completion.

438,431. Incandescent Electric Lamp Socket; James W. Collier, of New York, N. Y. Application filed Aug. 15, 1890. According to this invention, that portion of the key which enters the socket has on it a wing or wings, for the passage of which a suitable slot is formed at the edge of the opening or hole in the socket through which the key is inserted between the contact spring, these springs being so placed with reference to the slot that they will hold the key open or closed in a position where its wing or wings will be out of register with the slot.

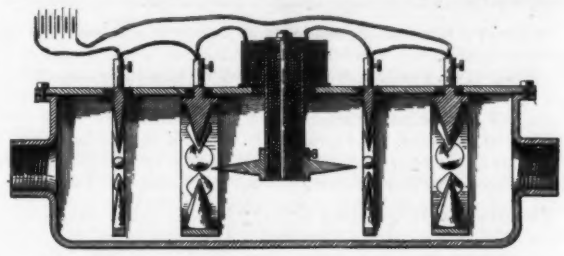
438,434. Magneto-generator; Noel B. Ginochio, of New York, N. Y., Assignor of one-half to Eliza M. Greene, of same place. Application filed Feb. 4, 1890. A magneto-generator in which the magnets are made up of a series of permanent ring-shaped pieces connected to pole pieces, the pole pieces being provided with projections conforming to the shape of the ends of the magnets.

438,452. Electric Railway Brake; Charles J. Van Depoele, of Lynn, Massachusetts. Applications filed April 9, 1890. An electric brake system comprising brake-actuating coils connected in a brake operating circuit, a source of current connected with said circuit, an electric dynamic counter electromotive force device spanning the main circuit, and means for increasing or decreasing the effect of the counter electromotive force device upon the current flowing in the brake-operating circuit.

438,495. Insulating Joint; Sydney H. Short, Cleveland, O. Application filed Dec. 10, 1889. In an insulated joint, the combination, with a metal casing having open ends and provided with a ball at one end, of an insulated lining or block secured within the casing, and a shank projecting from said casing at one end, the head of said shank being imbedded in the insulating lining.

438,525. Method of and Apparatus for Working Metals by Electricity; George D. Burton, of Boston, Mass. Application filed Aug. 12, 1890. The invention consists in the method of forming or shaping articles from a metal rod or bar by feeding said bar a given distance for the length of the article to be made, then cutting off from said bar a blank of the required length, then softening said blank by passing an electric current therethrough, then cutting off said current and feeding the softened blank to the working-dies, and then subjecting the blank to a forging or shaping operation.

438,530. Telegraph Key; Charles H. Crockett and Lansing C. Dedrich, of Schenectady, New York. Application filed April 2, 1890. In a telegraph key, the combination of a non-conducting



No. 438,579.—Means for Preventing Boiler Incrustation.

base-frame, oppositely arranged bearing-posts on the frame having connections to independent lines, a key-lever made of non-conducting material pivoted between bearing-posts and provided with conducting plates on its under side, separated from each other and having independent connections to opposite bearing-posts through the pivots of the lever, and oppositely arranged contact-points on the lever and base-frame, having independent connection to the batteries, whereby duplicate signals may be transmitted over two lines by a single key.

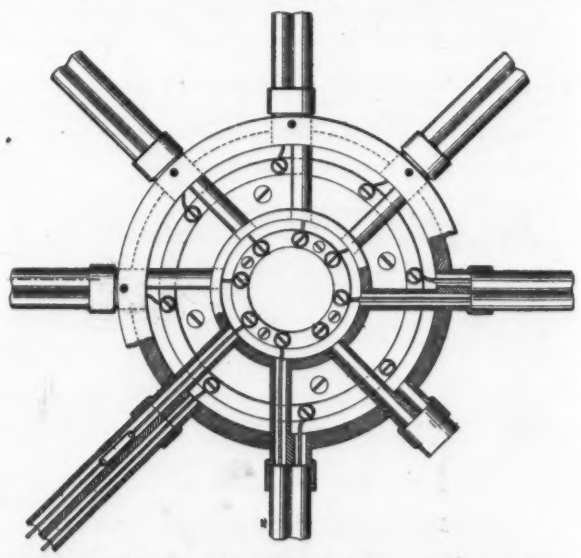
438,532. Insulating Appliance for Electric Batteries; Stanley G. C. Currie, of Philadelphia, Pa., Assignor to the United Gas Improvement Company, of same place. Application filed June 18, 1890. The invention consists of a cell, jar or vase provided with a depending rim or skirt adapted to be mounted on a fixed insulating base having a recess formed therein, in order to permit moisture to drip off the depending rim or skirt of the cell, jar or vase without forming a liquid circuit from one cell to the other.

438,564. Electric Railway; Horace E. Swift, of Boston, Mass., Assignor to Frank F. Corliss, of same place. Application filed May 15, 1890. In an electric railway, the combination, with two rails, one of which is made in sections alternately electrically connected, and a carrier provided with one or more electro-magnets and adapted to travel on said rails, of supports for said rails suitably insulated therefrom and making the armatures.

438,579. Electric Means for Preventing Boiler Incrustation; Albert B. Faunce, of Quincy, Ill., and Samuel G. Cabell, of Washington, D. C., Assignors of one-third to Milton S. Cabell, of Quincy, Ill. Application filed June 7, 1890. The invention consists in the combination of a water-feed conduit, a negative and a positive electrode of any suitable metals, material, or composition which will induce galvanic action, insulated from the body of the conduit and out of contact with each other, and wires or other means of coupling said electrodes outside the conduit or vessel, whereby said negative and positive elements may be coupled for use or uncoupled, and thus save the consumption or destruction of said elements when not required for use.

438,586. Galvanic Battery; Robert E. Murphy, of St. Louis, Mo., Assignor of one-half to William M. J. Crossmyer, of same place. Application filed April 2, 1890. A galvanic jar having an inside annular flange with a central orifice, adapted to receive a porous jar and a cover supporting an electrode.

438,590. Automatic Safety Cut-Out for Electric Circuits; Granville T. Woods, of Cincinnati, Ohio, Assignor to the Woods Electric Company, of same place. Application filed April 8, 1890. In combination with a generator, an outer circuit and an automatic cut-out device, a loop from the outer circuit around the cut-out but through a magnet controlling said cut-out, an armature make-and-break switch in said loop, and an extension



No. 438,592.—Electric Wire Distribution Box.

of the main-line wire through a magnet controlling said make and-break switch to ground.

438,592. Electric Wire Distribution Box; William H Eckert, of New York, and William H. Gregory, of Brooklyn, New York In a system for wiring houses or other structures, the combination of a distributing-box connected with the street mains or other conductors, two or more compartments within said box separated from each other by an insulating wall or walls, a series of distributing-conduits, each of which consists of a double pipe of insulating material leading from said box, the arrangement being such that corresponding tubes of the several conduits are brought within one compartment while the others are carried to the second compartment of said box, and a loop conductor whose branches are respectively placed within the two tubes of each double pipe and carried from a transformer of electrical energy into the separate compartments of a distributing box.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1886—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.